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Science & Technology for Rural India

PM Dedicates 'Statue of Unity' to the Nation

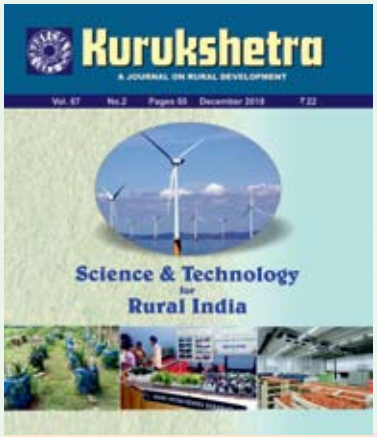
The Prime Minister, Shri Narendra Modi at the dedication ceremony of the 'Statue of Unity' to the Nation, on the occasion of the Rashtriya Ekta Diwas, at Kevadiya, in Narmada District of Gujarat on October 31, 2018.

The Prime Minister dedicated the world's tallest statue, the 'Statue of Unity', to the nation on October 31, 2018. The 182 metre statue of Sardar Vallabhbhai Patel, was dedicated to the nation on his birth anniversary, at Kevadiya in Narmada District of Gujarat. The PM also inaugurated the Wall of Unity. 31st October is observed as Rashtriya Ekta Divas.

Greeting the people of India on this occasion, the Prime Minister said that with the Statue of Unity, India has given itself a towering inspiration for the future and will continue to remind future generations of the courage, capability and resolve of Sardar Patel. He said that integration of India by Sardar Patel, has resulted today in India's march towards becoming a big economic and strategic power.

The Prime Minister, Shri Narendra Modi at the dedication ceremony of the 'Statue of Unity' to the Nation, on the occasion of the Rashtriya Ekta Diwas, at Kevadiya, in Narmada District of Gujarat on October 31, 2018.

The Prime Minister also recalled Sardar Patel's vision of the administrative services as a steel frame and described the Statue of Unity as a symbol of the self-respect of the farmers who gave soil from their land, and iron from their farming implements for the Statue. He said the aspirations of the youth of India can be achieved only through the mantra of 'Ek Bharat, Shrestha Bharat.'



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Editorial

Science and technology capabilities are fundamental for social and economic progress of the country. The necessity of harnessing science and technology for transforming rural India has long been recognised. In fact, Mahatma Gandhi had clearly shown an appreciation of this necessity. As early as 1935, at the All India Village Industries Association, Gandhiji initiated a movement called "Science for People", with an advisory board of national personalities including eminent scientists like J.C. Bose, P.C. Ray and C.V. Raman.

To a farmer in India, 'science' might seem a clueless concept. But put it into a rural context — organic farming, biotechnology, renewable energy sources, sanitation — and it begins to seem very relevant indeed. It's precisely this approach that the government has adopted in its countrywide push for scientific awareness.

The Prime Minister Shri Narendra Modi's focus is on "Go rural". This is the 'in' phrase in the current culture of economic planning and development. Accordingly, the phrase is gradually being translated into action by the Government through several positive steps in this direction. The commitment of the Government is reflected in launching several innovative schemes and programmes in sectors like agriculture, energy, infrastructure, sanitation and education. The sole objective is to empower the rural masses and bridge the digital divide.

Scientific inputs in agriculture are of direct importance to the rural sector to ensure better and sustained food productivity. So are the expansion efforts in many other sectors . Technology for rural areas must be aimed at creating gainful employment, recycling wastes to create value-added products, human welfare through better housing, sanitation, elimination of drudgery, promotion of non- conventional energy and speedy transfer of technology from lab to land, particu¬larly for remote areas. Science and technology are key drivers to development, because technological and scientific revolutions underpin economic advances and improvements in various systems which lead to better standards of life and close the rural urban gap in terms of amenities and facilities.

Developments in science and technology are altering the way people live, connect, communicate and transact, with profound effects on economic development of the country. The present government has realized that in order to promote advancement in science and technology, particularly for rural areas, investment in quality education for youth, and continuous skills training for workers and managers is needed. For India to grow and develop its economy it is necessary to grasp and apply insights from science and technology and use them creatively. Innovation is the primary driver of technological growth and drives higher living standards.

There is the need to coordinate for an effective strong impact of science and technology in rural areas – by balancing technological capability, economic opportunity, and societal requirements. Technology is ever evolving in India's R&D department and only requires the boost from an already lucrative market in rural India to meet job demands and basic facilities for a better quality of living, thus addressing what every village needs and must be provided with for a sustainable independent future of the India's rural life. This must be seen as an opportunity to develop more resilient agriculture and appropriate and affordable technologies for rural areas thereby making India a leading hub for knowledge and technology-intensive industries.

MODERN TECHNOLOGY IN IMPLEMENTATION OF RURAL DEVELOPMENT PLANS

Narendra Singh Tomar

The present government is in fast lane to achieve the desired results by using the latest technology on large scale in all the important schemes related to rural development. In fact, use of scientific methods, state-of-art technology and latest techniques, have greatly helped plan rural development schemes in a better way, execute qualitative work and monitor the rural schemes more effectively and with all these, it has become possible to ensure greater transparency in implementation of schemes.

India is the nation of villages and the soul of India lives in its villages. In true sense, without the progress and prosperity of the villages, the country's prosperity and well-being is inconceivable. Realizing this, the Government of India has been taking several initiatives for the all-round development of rural areas and the prosperity of the village folk. Progress in the past has been taking place at a glacial pace. More than seven decades have passed after getting independence from the British rule, but the villages are still going through the process of development. The root cause of this malady is that governments and the political parties who have governed the country for a long period did not pay that much attention to this aspect as should have been done. It is a matter of great satisfaction that the main focus of the present government, led by the Prime Minister Shri Narendra Modi, has been on the prosperity of the villages, the poor and the farmer and the results of these efforts as expected are noticeable.

The Ministry of Rural Development has been making sincere efforts to bring prosperity and well-being in the villages through its programmes and schemes viz. Pradhan Mantri Gram Sadak Yojana (PMGSY), Pradhan Mantri Awas Yojana-Gramin (PMAY-G), Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA), National Rural Livelihood Mission (NRLM), National Social Assistance Program (NSAP), Sansad Adarsh Gram Yojana (SAGY), Shyama Prasad Mukherjee Rurban Mission and Mission Antyodaya. In recent years, the schemes related to rural development have been re-structured and their implementation has also been made more effective. Besides, various measures have been taken to strengthen the monitoring system. In order to achieve the desired results of all rural development schemes, greater emphasis has been laid on adopting modern technology, cutting edge techniques and scientific methods in their implementation. Various initiatives have been taken for better planning, effective monitoring, greater clarity and transparency.

With the objective of providing pucca houses with basic facilities by 2022 to all the eligible homeless families and the households living in dilapidated houses, Pradhan Mantri Awas Yojana - Gramin was launched on 20th November 2016 . Under this, selection is as per the Socio-economic caste Census-2011. Assistance is being provided to those poor families who do not have roof over their heads and are unable to build their houses because of the shortage or lack of financial resources. 'Pradhan Mantri Awas Yojana' has created employment opportunities in the country on a large

scale and also catalysed skill development in rural areas. The allocation of massive budget provision for this scheme and its expenditure at village and block level is consistently strengthening the rural economy. In fact, it is not only a Programme, but an important nation-building campaign. The Ministry of Rural Development, in collaboration with State Governments and UNDP, HUDCO, Construction Skill Development Council of India (CSDCI), National Skill Development Corporation (NSDC), National Institute of Rural Development and Panchayati Raj and Indian Institute of Technology (IIT) Delhi, has undertaken training related initiatives in every state through which all housing zones are being provided with suggestions and guidance to adopt designs and construction technologies according to their geographical, environmental and other needs. Under this scheme, the target is to construct one crore residential units till March 2019. Under Pradhan Mantri Awas Yojana-Gramin, construction of 52.26 lakh houses has been completed by 19th November, 2018. In the implementation of this scheme, performance of Madhya Pradesh, Uttar Pradesh, West Bengal, Odisha, Chhattisgarh and Rajasthan has been commendable. The use of modern technology and new techniques in the implementation of this scheme has ensured transparency as well as helped in increasing the pace of implementation process. In each stage of housing construction, information technology based **MIS-AwasSoft**, mobile-based application-**Awas app** and space technology are being used on a large-scale for monitoring purpose. All transfers of funds to the beneficiaries are done on the basis of Electronic Funds Transfer Order (FTO). Fund transfer is not permitted in any other form. The entire work of this scheme i.e. from the selection of beneficiaries to distribution of funds, verification of progress of construction work till the release of funds is being done through MIS-AwasSoft. This has made it easier to monitor various aspects of implementation. To monitor the progress of housing construction, showing geo-referenced photographs with the help of mobile-based application-Awas app and uploading them on Awas Soft has been made mandatory. All photographs uploaded are geo-tagged and time-stamped. With the help of Android-based Awas app launched in April, 2016, at different stages of construction of houses, photographs containing geo-tag and time-reference can be recorded and uploaded. This has reduced the time taken to verify the progress of work. These assets can also be seen on Geo-Coordinated Bhuvan. ISRO has developed this software application through which 2-D/ 3-D images of the Earth's surface can be seen. Off-line module of this application has also been launched to register geo-tagged photographs

of houses in areas where there is no network connection. The use of SMS has increased manifold following the introduction of electronic funds transfer to the beneficiaries through the AwasSoft-PFMS platform. **Rural Housing Knowledge Network (RHKN)** has been started in collaboration with IIT Delhi with the objective to prepare multilingual web-portal in the public sector and to prepare comprehensive nationwide compilation of information related to business houses, institutions and practices associated with affordable and sustainable solutions of rural housing. It can be updated from time to time and it is available on the website *www.ruralhousingnetwork.in.* This is a question-and-answer-based platform prepared by various stakeholders of rural housing. In order to understand the real problems of different geo-climatic areas of the country, this knowledge network is helping house owners, masons, panchayats, districts, state governments, non-governmental organizations, corporate bodies and academicians enormously. State-wise documentary details of house design typologies/technologies are being prepared so that a collection of relevant knowledge can be prepared.

Rural connectivity is an important component of socio-economic development of villagers. It offers many facilities like education, health and marketing. The development of rural road network in the country has not been uniform. In India, when the era of planned development started in the year 1951, the road connectivity in the villages was negligible because only 20% of the villages had all-weather roads. During the Fifth Five Year Plan, in the year 1974, the development of rural roads was made a part of the "Minimum Needs Program". Due to this some progress in the development of rural roads was noticed. Under the various programs of Central and State Governments, pertaining to employment generation and poverty alleviation, rural roads were constructed but overall, there remained a misconception that there was no need for detailed design and engineering for rural roads. As a result, many thousand kilometers of roads were laid without the aid of proper design and engineering. Consequently, the geometrical design of rural roads remained poor and these roads could not last for long.

The subject of "Rural Roads" is included in the Constitution under the State List. As a result of the farsighted thinking of the then Prime Minister Late Shri Atal Bihari Vajpayee, the Government had, as part of the poverty-alleviation work plan meant for the assistance of the States, launched the Centrally- Sponsored Scheme of "Pradhan Mantri Gram Sadak Yojana" on December 25, 2000. The main objective of this scheme is to provide all weather roads to the habitations included in core network of plains areas not connected with roads and having population of 500 and more (as per 2001 Census). According to the Core network, the habitations not connected with roads and having population of 250 and more (as per 2001 Census) in Special category States like North East, Sikkim, Himachal Pradesh, Jammu and Kashmir and Uttarakhand, desert areas, tribal areas included in Schedule-V and 88 selected tribal and backward districts as determined by the Home Ministry / NITI Aayog are to be connected with roads. Under this program, single all-weather road connectivity has been envisaged for all eligible habitations. Under this, a model of decentralized network planning for rural roads is implemented.

On a special initiative of Ministry of Rural Development, the Indian Roads congress has published a Rural Roads Manual IRCSP: 20 on the geometric standards, design, construction and maintenance of rural roads. At present, in order to ensure proper design and preparation of the project, more than 60 reputed engineering and technology institutions in the country conduct independent investigations of project proposals.

These institutions are known as State Technical Agencies. National Rural Roads Development Agency has been constituted for technical and managerial assistance in the implementation of the program at the central level, whereas State Governments have constituted State Rural Road Development Agencies. Standard Bid Document (SBD) has been prepared on the basis of best national and international systems for construction contracts under the Pradhan Mantri Gram Sadak Yojana and the tendering process for all construction works is carried out on the basis of this document. To ensure transparency and to get the benefits of electronic tendering, the entire process of construction related contracts is being conducted only through e-procurement. Asian Development Bank approved technical assistance of US $ 500 million in December last year to emphasize on sustainability, innovative technology and anti-disaster mechanism in the development of rural roads in the country. It is the result of the use of modern technology and scientific methods that under the Pradhan Mantri Gram Sadak Yojana, 1, 68,394 out of 178184 eligible habitations have been connected by road till 19th November, 2018 which is 94.5 percent of the target. During the tenure of the present government, the growth of road construction has increased by 27 percent as compared to the last four years of the previous government. The speed of road construction in the year 2013-14 was 75 km per day, which increased to 134 kilometers per day in 2017-18.

Pradhan Mantri Gram Sadak Yojana-II has been started for improvement in existing rural road network. Under this, with the aim of making road network more vibrant, selected rural roads are being upgraded by the use of modern technology and parameters and the target has been fixed to construct 50 thousand kilometres of roads. Out of this, construction of more than 21,000 kilometers of roads has been completed. To develop road connectivity in areas affected by left wing extremism, funds to the tune of 11725 crores have been allocated and the target is to construct 5411 kms road by March, 2020. Now each state is required to set up simplified maintenance plan and management system to survey the actual situation of the inventory and the entire rural road network. Data-base is available on **OMMAS** and now it is also necessary to record on the GIS platform.

Under World Bank-assisted PMGSY-Rural Road Project-II, emphasis has been laid on adopting innovative and simplified methods of maintenance of rural roads. Under this, a mobile application **Aarambh** has been developed which helps in collecting necessary data for preparation of inventory of roads, GIS based mapping for survey of road surface, cost estimation and annual road maintenance plans and monitoring work. Modern Web-based on-line management, monitoring and accounting system, OMMAS has been set up to effectively monitor the entire program, bring in more efficiency in implementation and increase responsibility and transparency in the system.

Major application software modules include for rural road planning and core-networks, proposals, tenders and contracts, execution, quality monitoring, flow of funds and receipt and payment accounts. E-payment and e-procurement are new dimensions added to it. Using the dot-net technology, the new version of **OMMAS 2.0** has also been started. National Institute of Rural Development and Panchayati Raj has issued guidelines on technology initiatives for promoting cost-effective technology in the construction of rural roads using new materials, waste materials and locally available material. States have been advised to propose the use of any one of the new technologies for at least 10 percent of the roads involved in annual proposals including material

approved by Indian Roads Organization (IRC), about which specifications are already available. Besides, for additional length of 5 percent roads included in the annual proposal, States have been asked to propose the use of any one of the new technologies about which the guidelines of the Indian Roads Congress are not available. All states have been advised under PMGSY to start rural road projects for about 100 km long road on experimental basis, using cold mix technology in the construction of upper surface of the roads.

Keeping in view the use of non-conventional materials and environment-friendly Green Technologies in the construction of PMGSY roads, the Ministry of Rural Development has fixed state-wise targets regarding the use of waste plastic and cold mix technology. The project of mapping waste material and locally available material on the GIS platform has been entrusted to Central Road Research Institute, New Delhi. In March last year, a tripartite agreement was signed by National Rural Road Development Agency, Rural Development Ministry, National Remote Sensing Center, Indian Space Research Organization (ISRO) and National Institute of Rural Development and Panchayati Raj for use of Geo-Informatics and Satellite Imagery on real time basis and to verify the progress of implementation as per the information received from the states electronically.

To fulfil the objectives of e-Governance and Digital India, a new mobile application **Meri Sadak** has been launched on July 20, 2015 for resolving complaints related to PMGSY roads. It has been integrated into OMMAS to make it user friendly, to get citizen feed-back in transparent manner and also to resolve the complaints. The Meri Sadak app is available in 10 regional languages along with English and Hindi. Complaints can be made about poor quality, slow progress or halted works for any reason in PMGSY, through this application.

The scheme of providing at least 100 days of unskilled manual labour to each family in the form of guaranteed employment in a financial year according to the demand in rural areas is well-known as Mahatma Gandhi National Rural Employment Guarantee Act – MGNREGA. It is an important program to ensure inclusive growth of rural India. Under this, the emphasis is on strengthening the livelihood base of the rural poor and the creation of productive assets of set quality and sustainable nature. This has increased agricultural productivity and income of rural households. A budgetary allocation of Rs 55,000 crore, largest ever, has been provided for MGNREGA in the financial year 2018-19. An exclusive initiative named **Geo-MGNREGA** was introduced in the financial year 2016-17 to strengthen the scheme and also to underpin transparency and

Hon'ble Union Minister of Rural Development, Panchayati Raj, Mines & Parliamentary Affairs Shri Narendra Singh Tomar launching the Geotagging initiative of MGNREGA, on November 30, 2016 at Vigyan Bhawan, New Delhi.

monitoring mechanism in implementation. Under this initiative, space technology is being used for geo-tagging of all assets created through MGNREGA. In this scheme, 3.93 crore assets have been created so far. Out of these, 2.42 crore assets were created during the tenure of the present government. Under this, special attention is being given on creation of permanent assets, natural resource management, water conservation works and livelihood growth. Geo-tagging of 3.31 crore MGNREGA assets has been made available to the public domain. Large scale capacity building and training is being given in order to promote natural resource management planning process using geo-informatics. **Secure** (Software for Estimate Calculation Using Rural Rates for Employment) is an online application, specially designed and developed to prepare online estimates of MGNREGA works. Estimates received through this are also accorded online technical and administrative clearances. In the financial year 2017-18, an Android-based mobile application **Jan-MGNREGA** was launched which has a large-scale feed-back mechanism for the public. This has ensured greater transparency in the implementation of the program. Ministry of Rural Development has started the **National Electronic Fund Management System (NE-FMS)** from Jan 01, 2016 to further simplify the fund flow system. Funds are being transferred directly to beneficiaries in bank / post office accounts through this System in 24 States and one Union territory. In the year 2018-19 so far, the payment of 99 percent wages has been done directly in the account of MGNREGA workers electronically through direct benefit transfer (DBT) system whereas during the financial year 2013-14, only 37 percent payments could have been made electronically. 12.55 million job cards have been issued to MGNREGA workers and about 10 crore workers have been linked to AADHAR. 6.95 crore workers have been linked to the AADHAR -based payment system.

In this way, the present government is, in fast lane to achieve the desired results by using the latest technology on large scale in all the important schemes related to rural development. In fact, use of scientific methods, state-of-art technology and latest techniques, have greatly helped plan rural development schemes in a better way, execute qualitative work and monitor the rural schemes more effectively and with all these, it has become possible to ensure greater transparency in implementation of schemes.

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Digital Health Services : Some Key Initiatives

mSakhi: is an award-winning mobile phone app to help health workers in providing high-quality health care to the families in even the remotest villages in different parts of the country. **It** is an open source Android application developed specifically for the health workers in India. It's is an all-in-one job aid and electronic medical record system that replaces the paper-based tools and helps health workers get access to the latest training and information in an easy-to-understand and convenient format. With this app, ASHA workers can use their smartphones to update skills, stay in touch with supervisors, and track and report important data about health issues in their communities. They can use the app to teach new parents how to protect their babies from infection or dehydration, how to breastfeed, and how to identify symptoms of serious illness. If a mother or baby needs medical attention, an ASHA can use mSakhi to quickly refer them to a doctor who can help.

Kilkari app: Kilkari, which means 'a baby's gurgle', delivers free, weekly, time-appropriate 72 audio messages about pregnancy, child birth and child care directly to families' mobile phones from the second trimester of pregnancy until the child is one year old. Kilakri has been launched in Jharkhand, Odisha, Uttar Pradesh, Uttarakhand and High Priority Districts (HPDs) of Madhya Pradesh and Rajasthan in the first phase.

Mobile Academy: It is a free audio training course designed to expand and refresh the knowledge base of Accredited Social Health Activists (ASHAs) and improve their communication skills. Mobile Academy offers ASHAs a training opportunity via their mobile phones which is both cost-effective and efficient. It reduces the need to travel – sometimes great distances – and provides them the flexibility they need to learn at their own pace and at times they find convenient. Mobile Academy has been launched in Jharkhand, Madhya Pradesh, Rajasthan and Uttarakhand.

M-Cessation: This programme being provided as part of any mHealth initiative, aims at reaching out to those willing to quit tobacco use and support them towards successful quitting through text messages sent via mobile phones. When offered along with traditional services, M-Cessation has been found to be cost-effective in comparison to other conventional options for cessation support.

e-Hospital: It is an online registration services framework portal where people can avail online services such as registration and appointment, pay fees, view diagnostics reports and check for the availability of blood in government hospitals in this portal. It was introduced by the Government of India, to encourage the use of technology to connect and empower people in areas related to health. This type of service offers great relief to the people who run from one pillar to another pillar to secure blood during the hospitalization period.

e-hospital portal provides simple appointment process for the patients. It provides a detailed list of a total number of hospitals and various departments in a particular hospital to the user. One can choose from the list of available hospitals as per the preferences and requirements. The patient has to authenticate using Aadhaar number then select the hospital which he wants to visit and then select the department and the date of appointment. After filling up the required details, he receives an SMS with information related to the appointment. The hospitals can provide appointment slots for patients through online booking . Through this platform, the hospitals can manage the registration, appointment process easily and monitor them.

ANM On Line (ANMOL): ANMOL is aims to improve the quality, effectiveness and timeliness of the delivery of quality services, specially to rural populations, to ensure better healthcare for women and children. The application aims at bringing awareness to the remotest populations, underserved communities and urban slums and through images and videos, and educating them about initiatives on health, maintenance of good hygiene, basic health care and precautions.

Mera Aspataal: It is a Government of India initiative by the Ministry of Health and Family Welfare, to capture patient feedback for the services received at the hospital through user-friendly multiple channels such as Short Message Service (SMS), Outbound Dialling (OBD) mobile application and web portal. The patient can submit the feedback in seven different languages on mobile app and web portal; for the hospitals visited in last 7 days. The patient can also check the already submitted feedback. The collected feedback is compiled, analysed and visualized in the form of a dashboard accessible to the different stakeholders at facility, district, state and national level.

BUILDING AGRICULTURE INNOVATION SYSTEM

Dr Raghunath Mashelkar

In the new National Agricultural Innovation System, we must look for total innovation, involving technological and institutional innovations throughout the production, marketing, policy research and enterprise domains. From transfer of technology, we must move to learning by using `collective intelligence'. Farmer's role will no more be confined to learning, adopting and conforming. They must become co-creators of knowledge, process and innovation.

In India, we have daunting challenges. They range from substantial enhancement of our productivity to dealing with challenge of climate change to managing dry land farming to rapid elimination of poverty and malnourishment. They say that if you continue to do what you did in the past, you will get the same results that you always got. And we do not want that. This means we have to do things differently. This means we must resort to innovation.

More specifically, India needs to rapidly move towards `innovation led agricultural growth'. This has to be achieved with speed, scale and sustainability.

We have benefited from our established `Indian Agriculture Research System'. However, we need to understand that any National Agricultural Research System (NARS) is activity based. Agricultural Knowledge and Information Systems (AKIS) are output based. National agricultural innovation systems (NAIS), however, are **outcome** based.

This new emphasis means that rather than just supporting research and research organizations, or supporting the generation of outputs, such as agricultural knowledge and information, emphasis has to be now placed on supporting **outcomes** that lead to sustainable development and growth.

This means that we have to do things differently than we have done in the past. For instance, in the classic National Agricultural Research System, the emphasis was on technology transfer. In the new National Agricultural Innovation System, we must move to `total innovation', involving technological and institutional innovations throughout the production, marketing, policy research and enterprise domains. From transfer of technology we must

move to learning by using `collective intelligence'. Farmer's role no more will be confined to learning, adopting and conforming. They must become co-creators of knowledge, process and innovation. We must move from `funding for research and research infrastructure' to `strengthening' the systemic capability for `total innovation', backed up by an enabling policy environment that fosters innovation.

Is it possible to draw any lessons from innovation in industry and manufacturing and agriculture especially from the new paradigms that were emerging? The answer is yes.

The author of this article and the late legendary thought leader C.K. Prahalad, wrote a paper titled 'Innovation's Holy Grail' in Harvard Business Review in the July-August 2010 issue. The paper discussed how the combination of scarcity and aspiration had helped India develop its own brand of innovation – getting more from less for more people – not just for more profit. This was called the MLM paradigm, i.e. 'More from Less for More'. Six months after the paper was published in HBR, the World Economic Forum had a special session on 'More from Less for More' on 16 November 2010. There are lessons from this paper that are valuable for the Indian agricultural innovation system too.

The challenge for the Indian Agriculture Innovation System will be also to get `more from less for more'. This means getting more output or productivity by using less resource (land, water, money, inputs) to create benefits for more and more people, not just more and more profit.

The issue of going for `more' is obvious. Indian demand for food grains would increase from 192 million tonnes in 2000 to 342 million tonnes in 2030. The challenge is that this `more' has to be created with `less'.

Let us deal with the challenge of dealing with `less'. Take the land first. Diversion of arable lands for urbanization, industrialization and also for producing bio-fuels will mean less availability of land for agriculture. Availability of `Less land' is also due to degradation caused by soil erosion, soil salinity and water-logging problems. Available estimates show that over 120 million hectares of land is degraded.

Furthermore, in India, agriculture is dominated by small farmers, with small landholdings. The average size of the landholdings decreased from 2.30 ha (1970) to 1.32 ha (2000) and is likely to be reduced to 0.68 ha (2020) and then to 0.32 ha (2030).

Despite this `less' land per capita, we have to get `more' income for our farmers. This means developing technological innovations that suit less land holdings, or developing affordable implements (such as CSIR's 1 lakh Krishi Shakti tractor for small farmers) or involving these small land holders innovatively in agrisupply chain through institutional innovations.

First and the most powerful way of getting `more from less' is by using the power of new technology, such as information and communication technology, nanotechnology, space technology, modern biotechnology, etc. However, a robust policy level innovation is a must to achieve this.

For instance, GM crops present a great opportunity of getting `more from less' as is evident from the Indian success in Bt Cotton. With reference to GM crops, different nations have adopted different strategies. Some use `preventive' policies. No matter what, do not allow GM crops. Others use `permissive' policies. No matter what, within the next so many years, fifty percent of our crops will be GM crops. But the right policies are those that are `promotional but precautionary'. While using the most rigorous scientific validation, we must be promotional too. And we must promote the use of new technology in multitude of ways. Here are some examples.

We could have innovation through technology-enabled supply chain through the use of RFID, advanced GIS/GPS, tracing and traceability systems. We could get `more from less' by reducing wastage and ensuring quality throughout the supply chain.

Precision agriculture could be achieved with the use of advanced GIS/GPS and sensors can guide planting/irrigation, monitor yields, fine tune inputs and achieve `more from less' by improving yields as well as reduce the use of water and fertilizer.

Moderately skilled agricultural workers with access to smart apps using smartphones or tablets can benefit from digital farm extension and advisory services.

Farmers can have real time market information by using mobile communications, voice based call centers and expert systems for real time price discovery, weather information and cultivation trends.

Again we can achieve `more from less' by using leakage-free public distribution system, which uses computerized allocation of food grains, GPS/SMS monitoring, verifiable digital identify and web portal for public grievances.

Finally, we can have technology enabled crop insurance, where use of real time data from weather stations could be used to predict the rainfall and calculate the insurance payouts, which can be automatically transformed to the farmers through mobile banking. These seamless transections can achieve `more from less'.

The second powerful way of getting `more from less' is to empower more and more farmers, with more and more knowledge. This can happen if the farmer understands the soil that he is sowing his seeds in (soil health card), he understands the why and how of the micro nutrient and pesticide addition that he makes and so on.

The third way of getting `more from less' is by using the power of `collective intelligence'. We must have more innovators becoming active players in the Indian agricultural innovation ecosystem going beyond our formal research and innovation systems. The author has been privileged to chair the National Innovation Foundation (NIF) inspired by the father of grassroots innovation movement in India, Prof. Anil Gupta. It was formed with the belief that 1.25 billion Indians do not represent 1.25 billion mouths but 1.25 billion minds. NIF recognises such grass roots innovators across India. The NIF website (www.nif.org.in) lists over 200,000 such grassroots innovations. Several of these are in the field of agriculture. And we have found that many of these are by ordinary farmers.

Let us see one typical example. Dadaji Khobragade from Nanded was one such as `grassroots innovator'. NIF identified him and honored him. The improved paddy variety, HMT, developed by him has now diffused to several states covering more than one lakh acres. It has been included as a standard reference for thinness by Protection of Plant Variety and Farmer's Rights Variety (PPVFRA) also! There must be thousands of Khobragades in the country. Our formal agricultural innovation systems (such as MPKV) must partner with such farmers to get `more from less for more people in India'.

The fourth strategy is that more `collective intelligence' of the innovators must be used in enhancing the productivity of the workers in agriculture, while reducing or

removing the drudgery in their fields. Let me give some examples.

Women comprise over fifty per cent of the total work force in tea gardens in India. Plucking of tea leaves manually involves a lot of drudgery. Can we not develop a tea leaf plucking device? Millions of women have to bend their backs for hours standing with feet in the water to transplant paddy in the fields. Can we not develop a manual paddy transplanter, which will eliminate this drudgery. We, at NIF, decided to challenge the Indian scientists and engineers to solve these problems.

In the Sixth National Grassroots Innovation Award Function of NIF on March 9, 2012, the Hon'ble President Smt. Pratibha Patil announced the Gandhian Inclusive Innovation Challenge Awards for such challenges causing the drudgery for the women. Three awards worth Rupees ten, five, two and half lakhs were announced. NIF received more than 500 entries. Fifty four entries were short listed by an expert committee for developing prototypes. But finally, none of the entries were found award worthy. NIF is going for a fresh round of challenges now.

Is it not strange that a country that is capable of doing the most challenging Mission to Mars in US $74 million, ten times cheaper than other nations, and that too becoming the only nation to do it successfully the first time, is unable to solve these problems, which will remove the drudgery of our women in agriculture? We must get the best of minds in our research and innovation system involved in these so that the noble aim of `more output with less drudgery' will be achieved with our 'collective intelligence'.

The Way Forward:

In this article, the Indian Agriculture Innovation System has been discussed. However, overall, how is India doing on innovation?

The decade of 2010-20 was declared as the Indian Decade of Innovation. We are almost at the end this decade – and where are we? Look at the world ranking of India in innovation based on the report published by Global Innovation Index. India's ranking among 143 nations has slipped from 62 (2011) to 64 (2012) to 66 (2013) to 76 (2014), 81 (2015). However, in the subsequent years, it has steadily improved,66 (2016), 60 (2017) and 57 (2018). That means after halfway through the decade, India has slowly started moving up the ladder of the global index.

The very dictionary of innovation is changing due to the innovations done in India. These new terminologies in this dictionary now include phrases like frugal innovation, inclusive innovation, Gandhian innovation, nanovation (after the Tata Nano Car), reverse innovation and even `Indovation'! And all these refer to India's ability to do `more from less for more people'. That means India is creating its own imprint on the global innovation scenario. That means India is doing well. So what is the truth?

I believe there is both good news and bad news for India. Global Innovation Index is largely based on technological innovation. Other countries appear to be speeding faster than India in technological innovation. But India excels in non-technological innovations such as business model, system delivery, workflow, organizational, institutional innovations, etc. It also excels in grassroots innovation. The Global Innovation Index must be redesigned to account for all this.

We must build a robust Indian Agricultural Innovation System based on our great strengths. We must build it on the `total innovation' concept with `collective intelligence' of this great nation. We must have highly innovative pro-poor, pro-environment and pro-business policies.

We must build our own Indian Agriculture Innovation Index. It is important to do so, because what cannot be measured, cannot be monitored. And what cannot be monitored, cannot be improved. I have no doubt that if we do this with determination, then we will achieve the dream of moving rapidly from `green revolution' to much needed `evergreen revolution' and `nutritional revolution'. We will then achieve our dream of `food for all' with a smile on the face of a billion plus Indians, and not just some privileged few amongst us.

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KRISHI VIGYAN KENDRA: PROMOTING SCIENTIFIC TEMPER

Dr Manish Mohan Gore

KVKs are emerging as the regional knowledge hubs and gaining trust of the farmer community. KVKs are the integral part of the national agricultural research and extension system and the strength of this entity is embedded in its multidisciplinary structure, multi-stakeholder ownership and multifarious activities. KVKs conduct training and emphasize on learning by doing. These are the core substances of scientific temperament. Hence we may consider KVKs as the vital promoters of scientific temper among the farmers.

Innovation in agriculture has always shaped the destiny of a promising country like India. The diffusion of science, technology and innovation in agriculture is rather the key to increase agricultural production in a sustainable manner. Role of science and technology in agriculture is pertinent to not only ensure national food security, but it also provides farmers to maintain affordability of food items for the public. In order to draw true potential of farmers towards the state of the art technologies for the betterment of agriculture, Indian government has set up a big chain of over 700 Krishi Vigyan Kendras (KVKs) across the country.

Krishi Vigyan Kendras are present in almost whole geography of our country. They are doing yeoman service to the agriculture sector even in the most difficult areas of the country. KVKs are emerging as the regional knowledge hubs and gaining trust of the farmer community. KVKs are the integral part of the national agricultural research and extension system and the strength of this entity is embedded in its multidisciplinary structure, multi-stakeholder ownership and multifarious activities. KVKs conduct training and emphasize on learning by doing. These are the core substances of scientific temperament. Hence we may consider KVKs as the vital promoters of scientific temper among the farmers.

Origin, Philosophy & Objectives of KVK:

The concept of Krishi Vigyan Kendra was given by Dr. M. S. Swaminathan, initiator of green revolution in India and the father of Indian agricultural research. Dr. Swaminathan convinced Government of India that there is dire necessity to develop Krishi Vigyan Kendra in each district of India with an objective to cater activities such as technology assessment, refinement and demonstration of technology product. In light of this inspiration, the Government of India established first KVK in Pondicherry during 1974 with the financial support and able guidance of Indian Council of Agriculture Research (ICAR). In Kapgari Village of West Medinipur district, the first KVK in West Bengal and second in India was established in the year 1976. Since then, KVKs have been established in all Indian states and the number continues to grow. Presently, around 695 Krishi Vigyan Kendras are existing in different districts of India. A KVK can be created under a variety of host institutions including agricultural universities, state departments, ICAR institutes, other educational institutions or NGOs. A KVK must own about 20 hectare of land for the purpose of testing advanced agricultural technologies.

KVK is in fact an agricultural extension centre in our country. The meaning of KVK is 'farm science centre'. Usually associated with a local agricultural university, these centres serve as the vibrant

link between the Indian Council of Agricultural Research and farmers, and aim to apply agricultural research and development in a localized ambience. ICAR has 11 Agricultural Technology Application Research Institutes (ATARIs) throughout the country and all the Krishi Vigyan Kendras fall under ATARI. The objective of the ATARI is to plan, monitor, evaluate and guide the programmes of the KVK and judge the performance of KVKs time to time.

The objectives cum activities of Krishi Vigyan Kendras can be summarised as below:

i) **On Farm Testing of new Technologies:**

KVK act as a small laboratory and extension centre for agricultural research. Each KVK operates on a small farm to test new technologies related to seed varieties or innovative farming methods, developed by ICAR institutes. Through this platform, new technologies are tested at the local level before being transferred to the farmers. In this way, KVK serves as a centre to try and test forthcoming agricultural technologies.

ii) **Frontline Demonstration Centre:** Because of the KVK's farm and its proximity to nearby villages, it organizes programmes to show the efficacy of new technologies on farmer fields. Such frontline demonstration outlets showcase new agricultural technologies to be introduced in the farming community.

iii) **Capacity Building:** KVK also hosts capacity building programmes and workshops to discuss modern farming technologies with group of farmers and cultivators.

iv) **Multi sector Support and Advisory Services:** Krishi Vigyan Kendras offer support to various private and public initiatives through its local network and expertise. Government research institutes in general, leverage the network of KVKs while performing surveys with a wide range of farmers. Due to the growing use of ICT, KVKs have implemented technologies to provide farmers information, such as weather advisories or market pricing, through radio, mobile phones and social media.

In each of the above mentioned activities, the KVK focuses on crops and methods specific to the local climate and industry. Some factors which may impact this rational decision are soil type, crops grown, water availability, seasonal temperatures and allied sectors such as dairy and aquaculture etc. In addition to addressing local factors, KVKs are also mandated to increase adoption of practices that align with profitable agriculture, climate smart agriculture and dietary diversification. Some KVKs also host social activities to facilitate close pact between the institutions and the local community.

Apart from above activities, KVKs also conduct training programmes for farmers to update their knowledge and skills in modern agricultural technologies. In this programme, extension personnel are trained to orient target farmers in the frontier areas of agricultural technology development. These KVKs also work as resource and knowledge centres of agricultural technology for supporting initiatives of public, private and voluntary sector for improving the agricultural economy of the district.

Aligned to strengthen the efficiency of KVKs, a study was conducted by the National Institute of Labour Economics Research and Development (NILERD), an autonomous institute under NITI Aayog in the year 2017. The aim of this study was to find out the impact of KVKs on dissemination of improved practices and technologies, in terms of outreach, knowledge, accessibility

etc. The study intended to examine the efficacy of KVKs' services, assess them in terms of infrastructure and human resources, impact of new knowledge and practices on farmers' farming methods and the impact of new knowledge adoption by farmers on their income and quality of life. This study was based on field survey of 46 KVKs, covering about 1800 farmers in five States (Rajasthan, Madhya Pradesh, Maharashtra, Tamil Nadu and Arunachal Pradesh) following stratified random sampling technique. To substantiate, focused group discussions were organised with various stakeholders and best practices were earmarked.

The study found that KVKs are playing a prominent role in transferring new technology at field level with beneficial impacts. They have an edge in technology transfer over other service providers by virtue of their having better technical expertise and demonstration units. About 40% farmers reported that they implemented the technology immediately after its dissemination by KVK and that 25% did so from the next agricultural season. With the intervention by KVKs, about 80% of the farmers have modified their agricultural patterns which were related to diversification of crops and changes in cropping pattern, seed planting technique, use of fertilizers and pesticides, changes in machinery used and in water use pattern. More than 50% of the farmers have mechanized their farm operations; however, ownership of farm machinery and technology adoption increased with the size of holdings and education level of the farmers.

This study predicts a better future of KVKs. It exhibits that through KVKs, agriculture related technological development is getting momentum and the final outcome of this expedition is to support national development through a scientifically tempered approach.

KVK: A tool for promoting Scientific Temper

The Indian agriculture faces many challenges on a broad perspective. High number of small land holder farmers, lack of supply chain infrastructure and extreme weather conditions are such major challenges. A key strategy in addressing such issues, in addition to policy support and a functioning market, is using science and technology in an innovative manner to better understand and adapt to complex challenges. This approach is called rational and scientific method. Scientific method comprises of five major components i.e. observation, hypothesis, experimentation, analysis and conclusion. The person who applies this approach of thought process in his/her daily life, then it means he or she is taking rational and justified decision in all walks of his/her life. This temper or attitude is commonly known as scientific temper or attitude. This is a form of mindset which can be found both amongst educated and illiterate persons. Farmer is a good

example in this context. Those farmers, who are not educated, apply scientific temper and take right decisions at the right moment of time in their farming practices. In this to happen, their past experiences, observation and analytical mind play a crucial role.

If we see the methodology of a KVK, we may definitely consider it as the vital agent or promoter of scientific temper in the society. KVK arranges the testing of any improved technology along with farmers' practice in their field with active participation of both the scientists and farmers. In this method having scientific approach, improved technologies are tested to compare and verify the results.

According to the suggestions and input of the farmers as well as local soil and climatic conditions, the improved technology may slightly be modified by the scientists of KVK to get maximum crop production. All these functions of the KVK are undertaken as per the suggestion and approval of the Scientific Advisory Committee. Meeting of the Scientific Advisory Committee is held once in a season to review the work done by the KVK and provide suggestions for future plan of work. The future technical programme of the KVK is prepared as per the suggestion of the farmers of that particular area. In these programmes, farmers' experiences are considered as one of the core backgrounds. In addition to these activities, each KVK has got different demonstration units such as mushroom unit, bio-fertilizer unit, vermicomposting unit, bee keeping unit, fruit preservation unit etc. These units help the villagers along with the farmers to increase his/her confidence on a particular enterprise.

The KVKs are the core centres of Indian agricultural extension system, comprising scientists from different disciplines of agriculture. A farmer who approaches KVK can get information in all the relevant areas of his farming. The KVK also provides intensive training to the farming community through the programmes conducted both within and outside the KVK premises. These programmes help support farmers to enhance their knowledge and skills related to farming as well as make them aware about new agricultural technologies in a rational manner.

Krishi Vigyan Kendra Portal: Extended Arm to the Farmers

Till the recent past, the efficacy of KVKs was difficult to measure due to the large number of farmers served by a single KVK and largely offline communication between the KVK and farmers. For this reason, research over the last 25 years has focused on the capacity of KVKs to make use of ICT for the purpose of a better management of communications with farmers. Plenty of applications have been developed, sharing advisories such as weather information and market pricing, supplementing the KVK's communication with its beneficiaries. However, many of these initiatives are of short impact, since the teams at each KVK often do not have the capacity to maintain software applications or because farmers do not find the information useful.

In 2016, Indian government launched Krishi Vigyan Kendra Portal to provide the information and advisory to the farmers and facilitate online monitoring of the KVK activities. At this portal, major events are reported on regular basis and reports are submitted online on monthly basis. This portal provides information of future plans and programmes of KVKs which benefit farmers, entrepreneurs and youth in joining different training programmes being organised by KVKs. Visitors can give their feedback on the content of the portal and programmes of KVKs. This component helps in order to improve the objectives of the portal and KVKs.

It has also been found that the technologies adopted by KVKs led to higher productivity, enhanced income and reduction of drudgery. The KVKs reported that a number of technologies were gender sensitive and had helped in reduction of drudgery, income enhancement and development of self confidence among women. Enhanced income is spent in construction of house, better education and health for family and better inputs for agriculture.

KVKs aim at comprehensive rural development and hence training on employment and income generating activities like wire basket making, tailoring, preservation techniques, agarbatti making, leather bag production, rope making, candle making, bee keeping, goat and pig rearing and such many other agriculture based training are

organized for school drop outs, especially women, so as to make them earn during off season. These trained people can start their own enterprises in local areas generating employment for the local rural youth. Thus, farmers are not the only beneficiaries of KVK but also the rural masses in one or another form are benefitted from the activities of KVKs. KVKs also formulate specific programmes for school children. Seminars, awareness camps, training programmes and study tours are also organized for school children on biodiversity conservation, kitchen gardening and tree planting. These activities sow seeds of creativity and scientific temper among the children right from beginning.

Conclusion:

Krishi Vigyan Kendras provide requisite knowledge through trainings and other activities to improve the skill and attitude of the people particularly farmers towards new technology and approach in farming, provide proper guidance to solve any problem faced by the farming community in agriculture and allied fields. Scientists working under KVKs provide inspiration, constructive and constant advice to the people of that area to start new entrepreneurship for their livelihood and show them a proper way when needed. Krishi Vigyan Kendra acts as a lighthouse of new knowledge and technologies in agriculture. It develops scientific temper among the farmers, general public, women and youth to enhance skill which further enable them to contribute in the national development.

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New Scheme to Promote young Entrepreneurs in Cooperatives

To cater to the needs and aspirations of the youth, the National Cooperative Development Corporation (NCDC) has come up with a youth-friendly scheme 'Yuva Sahakar-Cooperative Enterprise Support and Innovation Scheme" for attracting them to cooperative business ventures. The newly launched scheme would encourage cooperatives to venture into new and innovative areas.

The scheme will be linked to Rs 1000 crore 'Cooperative Start-up and Innovation Fund (CSIF)' created by the NCDC. It would have more incentives for cooperatives of North Eastern region, Aspirational Districts and cooperatives with women or SC or ST or PwD members. The funding for the project will be up to 80% of the project cost for these special categories as against 70% for others. The scheme envisages 2% less than the applicable rate of interest on term loan for the project cost up to Rs 3 crore including 2 years moratorium on payment of principal. All types of cooperatives in operation for at least one year are eligible.

NCDC, being the most preferred financial institution in the world of cooperatives, has also embarked on Sahakar 22, a Mission for Doubling Farmers' Income by 2022. The NCDC has the unique distinction of being the sole statutory organisation functioning as an apex financial and developmental institution exclusively devoted to cooperative sector. It supports cooperatives in diverse fields apart from agriculture and allied sectors. It is an ISO 9001:2015 compliant organisation and has a distinctive edge of competitive financing. It has extended financial assistance of Rs 63702.61 crore during 2014-2018 (as on November 13), 220% more than Rs 19850.6 during 2010-14.

KNOWLEDGE MANAGEMENT THROUGH DIGITAL TECHNOLOGIES

Dr C. Kathiresan

Traditional Knowledge Management systems including classroom teaching and distance mode programs in rural development sector, mostly resulted in 'knowledge push' and very less scope for interactivity. There is a paradigm shift in reaching-out information and knowledge to rural communities, owing to the affordability of internet and mobile phones in rural India. The recent trends in Information and Communication Technology (ICT), including Web Portals, Social Media, Expert Systems, e-Learning, Mobile Apps, Internet of Things (IoT), Digital Videos, Community Radio etc. have made 'Knowledge Sharing' more efficient and timely.

A knowledge based society and knowledge sharing environment can make the development process sustainable and accelerate the process of achieving the development goals. In this era of 'knowledge sharing', making access to the required information and knowledge is the key to empowerment of citizens. Rural Development sector, in terms of financial investment, knowledge and information is expanding dramatically. There has been expertise and rich experiences evolved by many institutions and organisations engaged in the promotion of rural development in India. Reaching-out right knowledge to the right people at right time is always a challenge, owing to various reasons including accessibility and authenticity of information and knowledge from different sources. Adopting a suitable Knowledge Management system or combination of systems and tools is important to reach-out the target audience (84 crores of rural population in 6,50,000 villages) with intended information and knowledge. Before discussing in detail about various knowledge management systems and tools, it is better to understand the concept of 'Knowledge Management' and its relevance in rural development process.

Knowledge Management (KM), a process of leveraging collective knowledge in a particular domain/institution/organisation, traditionally includes four processes, i.e, knowledge creation, knowledge storage and retrieval, knowledge transfer and knowledge application. Knowledge creation is bringing together new knowledge, useful to solve problems or making decisions which were not possible before. Knowledge storage is the process of making the knowledge persistent in order to allow later access. Knowledge retrieval is used to support efficient access to the stored knowledge. The process of knowledge transfer is needed to deliver the new knowledge to the target group from time to time (e.g. new schemes, policies, technologies etc.), which was only available with organisation/ institution before. Knowledge application is needed to gain benefit from the knowledge by solving problems with the help of that knowledge acquired by the community.

Traditional Knowledge Management systems including classroom teaching and distance mode programs in rural development sector, mostly resulted in 'knowledge push' and very less scope for interactivity. These systems are more 'process-centric' rather than 'people-centric'. But, rapid technological developments over the years, have made the knowledge management process more interactive and people centric. There is a paradigm shift in reaching-out information and knowledge to rural communities, owing to the affordability of internet and mobile phones in rural India. The recent trends in Information and Communication

Technology (ICT), including Web Portals, Social Media, Expert Systems, e-Learning, Mobile Apps, Internet of Things (IoT), Digital Videos, Community Radio etc. have made 'Knowledge Sharing' more efficient and timely.

Web Portal :A powerful Knowledge Management tool

The web is a vast source of information and more often it becomes difficult for users to sieve the specific information of interest. In such situations, web portals come in handy. Web portals are specially designed single access points to information collected from diverse sources. The information is arranged in portlets in a uniform way for users to access. Web portals can be classified as horizontal (providing broad range of content for general user) or vertical (targeted offering for niche users), also called vortal. Web portals designed for rural advisory services are generally of the second type. Building portals/knowledge repositories cannot guarantee its application to the target groups including Rural Development functionaries and communities. There should be clear cut knowledge uptake strategies and activities. Such strategies include - understanding Knowledge Pathways, developing knowledge products for non-negotiable adoption points, sequencing the knowledge interventions such as capacity building, embedding knowledge with technologies at field level, feedback and sharing among the communities and re-invention of knowledge at field level.

Some of the key web-portals hosting credible information on Rural Development in India, include – Vikaspedia (www.vikaspedia.in), India Panchayat Knowledge Portal (www.panchayatgyan.gov.in), India Portal (www.india.gov.in), Ministry of Rural Development Portal (www.rural.nic.in), NIRD&PR portal (www.nird.org.in), Panchayat Enterprise Suite (www.panchayatonline.gov.in), Digital India Portal (www.digitalindia.gov.in) and DISHA Portal monitoring 42 National Flagship Schemes (www.socialcops.com).

In India, most of the websites (76%), particularly Government websites, are available only in English and about 24% of the websites host bilingual content (Hindi/regional language). These websites are largely institute websites that have a greater focus on organization related aspects. The only predominantly available user centric information is that of policies and schemes of that particular institution. Limited scope for the users to share their experiences and knowledge with others and interact with experts or peers.

Social Media : A cost effective tool for knowledge sharing

Rural Development process demands continuous interaction among multiple stakeholders – public, private, and non-profit – and learning to take collective action. These services have been called upon to be less 'top-down' and more interactive, and social media can be a potentially powerful tool in this regard. With increasing reach among rural people, especially the youth, through increasing mobile phone subscriptions and decreasing data tariffs, social media is the best knowledge management tool as on today to reach-out the target group in rural areas in shorter time and more effectively. Social Media includes social networking sites (Facebook, LinkedIn), Messenger Apps (WhatsApp), blogs (Blogger, WordPress), microblogs (Twitter), video sharing tools (YouTube), podcasts, Wikis and many more. The high level of user engagement in social media also makes it one of the most participatory mediums of extension. This makes the sharing of data, information, and knowledge faster, easier, and more cost-effective, while at the same time enabling collaboration and demand-based knowledge delivery.

Most social media platforms are available free of cost. Sustainability depends upon the ability of the members to feed the content, add value to content, and support purposeful online engagement. Social media sustainability depends on the capacity of the stakeholders (individuals, groups, and organisations)

Vikaspedia Knowledge Portal

Launched in 2008, as part of India Development Gateway initiative of Government of India, Vikaspedia portal (www.vikaspedia.in) is aimed at creating versatile collective knowledge repository and demand driven information in the rural development oriented sectors including Agriculture, Health, Education, Social Welfare, Energy and e-Governance. This **multilingual portal** is serving as a collaborative content creation, knowledge sharing and utilization platform for the stakeholders in these 6 sectors. Currently, Vikaspedia is one of the largest knowledge portal hosting information/ knowledge in 22 Indian languages and English, offering information on success stories, best practices, government schemes, technologies and related value added services in development sector.

to address the dynamic information needs of clients and create networking opportunities with peers.

Smart Phones: Dynamic power house of Knowledge

Strategic reforms in telecommunications sector since 1990's have facilitated strong ICT infrastructure in India, particularly it revolutionised the mobile penetration in rural India. As on 31st August 2018, the total number of mobile users in India were 1167 million (91% of total population), including 519 million subscribers from rural areas, as estimated by Telephone Regulatory Authority of India (TRAI). Mobile devices are handy and facilitate content creation, storing, accessing and sharing information anytime, anywhere. Moreover, technology advancement has led the usage of mobile phones from mere 'voice calls' to other useful services like messaging, internet based data services and Apps, making the community more connected and knowledge empowered. Introduction of smart phones, competition among service providers, availability of basket of online services and policy support from Government, has made the mobile phones affordable and acceptable by rural India, in a shorter time than expected.

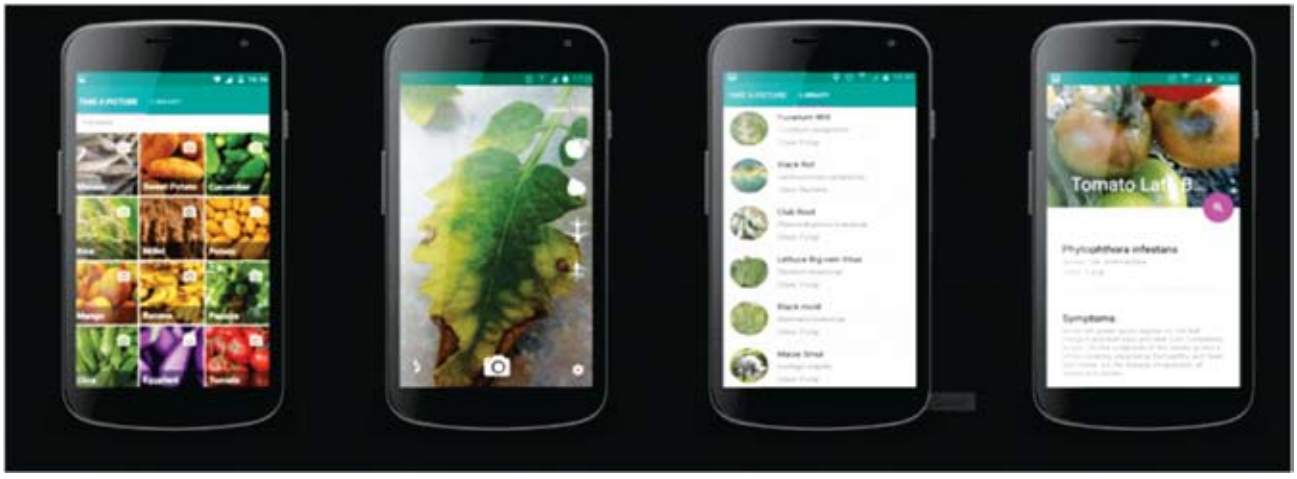
The success and failure of mobile based services broadly depends on the target group, demand driven content, mode of delivery (SMS, voice, video etc..) and sustainability model. Some of the successful mobile based services implemented in India, is listed below.

- **Rural Development:** *DISHA, Gram Samvad, Awaas App (PMAY-G), Mission Antyodaya App, My SHG App*
- **Agriculture and allied sectors:** *IFFCO Kisan Sanchar Ltd (IKSL), Fisher Friend, mKisan, Reuters Market Light (RML), mKRISHI, Kisan Call Centre, Annapurna Krishi Prasaar Seva, eNAM*
- **Banking:** *BHIM App, PhonePe, PayTm, FreeCharge, Airtel Money, Idea Money*
- **Health:** *mSWASTHYA, MOTHER, Indian Blood Donors, Blood4India, eMamta, eAushadhi, Sanjeevani, 1mg App, mTIKKA*

Understanding the need for promoting mobile based services, Ministry of Electronics and Information Technology, Government of India has launched 'Mobile Seva' initiative for mainstreaming mobile governance in the country. It provides an integrated platform for all Government departments and agencies in the country for delivery of public services to citizens over mobile devices using SMS, USSD, IVRS and mobile applications (Mobile Seva: www.mgov.gov.in).

Expert System : A virtual expert tool providing solutions for common problems

An Expert System is basically a software application that attempts to reproduce the performance of an expert in a particular domain. Expert system adopts artificial intelligence to solve a particular problem with the help of pre-set conditions in the software application. Mostly these systems are used as offline applications where there is an issue of internet connectivity and non-availability of subject experts to provide solutions in remote areas. There are expert systems available in Agriculture and allied sectors developed by Indian Council of Agricultural Research (ICAR) and are widely used in Krishi Vigyan Kendras (KVKs) and other organisations working in remote villages. 'Plantix' is a mobile based plant disease diagnostic tool getting popular in recent days.



Plantix Mobile App – Plan Disease Diagnosing Tool

E-Learning : A solution for large scale capacity building

Technology Enabled Learning (TEL) including online courses, remote classrooms, video conferencing etc. plays a major role in rural knowledge management. Training and capacity building of rural functionaries is a time-bound and continuous process. E-Learning platforms could be used for offering online courses for focused groups in a convenient and consistent manner, providing opportunity for anytime-anywhere learning for the community. Massive Online Open Courses (MOOCs) are recent trends adopted by many organisations to offer free online courses. Popular MOOC platforms include, SWAYAM (MHRD, Government of India), Coursera, edX, Khan Academy, Udacity and Future-Learn.

Adopting ICTs for Capacity Building of Panchayati Raj Institutions (PRIs): There are 2,62,547 Panchayati Raj Institutions functioning in India (as on October 2018), which includes 2,55,576 Gram Panchayats, 6354 Block Panchayats and 617 District Panchayats. The chronic PRIs management problems are compounded by the presence of a large number of Elected Representatives (ERs) across three levels, to the tune of 31.0 lakhs (including 14.39 lakh Elected Women Representatives), coupled with higher attrition rate with every election cycle and low levels of managerial experience/capacities and exposure. Approximately 30 lakh functionaries assist the elected representatives to manage the PRIs. In view of their presence on the scene for just 5 years, and it is likely that new set of elected representatives will be on the stage after every five years, is a major problem in terms of constraints of touching them with capacity building effort by various organisations and enabling them with continued learning. In order to address this issue, National Institute of Rural Development and Panchayati Raj (NIRD&PR), Hyderabad has adopted Information and Communication Technology (ICT) as the best way to reach-out and impart training to the 60 lakh Elected Representatives and Functionaries associated with PRIs. Efforts are underway to launch series of online courses on Panchayati Raj Governance and Rural Development, through customised e-Learning platform which can be accessed through web and mobile platforms.

Community Radio:

Community Radio is a broadcasting system established by the efforts of a specific community, operated by them for the purpose of the community's welfare. These stations are collectively owned by the community, trust or foundations in that locality. As on today, there are 186 Community Radio stations operational in India, including 40 in rural areas. The 'Sangam Radio' started in 2008, by Deccan Development Society (DDS) in Telangana, is the first NGO operated Community Radio, successfully operated by women's collectives for the past 10 years. Most of the Rural Community Radio Stations focus on creating awareness and providing knowledge on community development problems ranging from culture, rural development, education, hygiene and sanitation, agriculture to local governance. However, unlike other countries, Community Radios are not so successful in India, owing to many reasons including lack of funding, program skills, technology and licencing issues. Government intervention is required to resolve these issues and promote setting-up of more Community Radios in rural areas.

Conclusion:

Adoption of digital technologies in the knowledge management process have brought drastic change in reaching the unreached in rural areas, with credible information, knowledge and services. Modern ICT tools including web-portals, mobile phones, social media and expert systems have made knowledge sharing as 'people centric' rather than 'process centric'. The Mobile and Internet have undoubtedly brought substantial change in access to information, knowledge and services in rural India. At the same time, providing credible content, which are region specific and in local languages, are key factors to be considered while designing any knowledge management and service delivery model for rural communities. Undoubtedly, adopting digital technologies is the only way to reach-out and impart continuous training to the Functionaries and Elected Representatives associated with Rural Development and Panchayati Raj system in India. The Digital India programme of Government of India, is definitely accelerating the rural development process, by creating digital infrastructure at village level, digital awareness to rural communities and offering basket of digital services.

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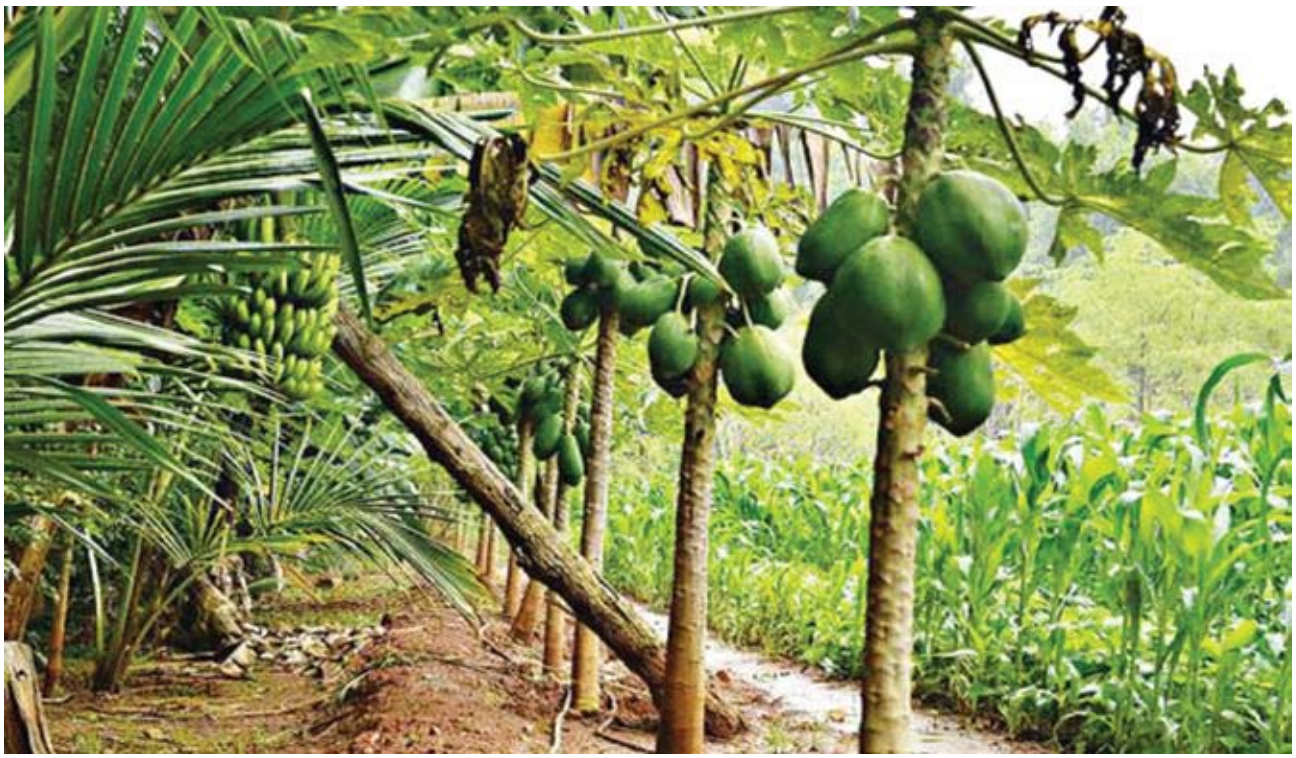
INNOVATIVE TECHNOLOGIES FOR HIGHER PRODUCTIVITY

Dr Y S Shivay and Dr Teekam Singh

Natural resources comprising of soil, water, vegetation and climate form the essence of all kinds of life and provide support to its various processes. Intensive input based high tech agriculture during last three decades has stressed these resources. Degrading quality of natural resource base is threatening quality aspect of agricultural produce. To improve productivity in agriculture the focus has been on the improvement of efficiency of critical inputs like irrigation, seeds, fertilisers and mechanization. Recently, there have been enormous innovations in agricultural production, not only improving productivity, but just as importantly, safe guarding the environment.

India has achieved a remarkable growth in production and productivity of various agricultural commodities over the last five decades. Major changes in agricultural production took place in mid-1960s with introduction and adaptation of new production technologies which is known as "Green Revolution" technology. Initially introduced in resource endowed areas in late 1960s it spread into other parts of the country during 1980s. The agriculture sector observed spectacular growth of over 4% per annum during 1980 to 1990. However, this growth rate did not sustain during 1990s due to several reasons including slowdown in public investment, low yield growth, decline in food productivity, declining water table and environment led stress problems, climate changes etc.

Agriculture is still the main livelihood of approximately half of the rural households in India and contributing over 16% to its gross domestic product (GOI, 2018). The population of India is growing at 1.24% per annum and is expected to increase from 1.21 billion in 2011 to about 1.46 billion in 2030. It is estimated that in the year 2035 the total domestic food grains demand will be 398.6 mt and milk 237.8 mt against 264 mt and 132.4 mt respectively in 2013-14. To meet the estimated demand, the yield level over the base period yield (1994-95) is required to be enhanced by more than 50%. It is pertinent to mention here that these targets are to be achieved in a scenario of several odd factors which will constraint the sustainable development of agriculture. Natural resources comprising of soil, water, vegetation and



climate form the essence of all kinds of life and provide support to its various processes. Intensive input based high tech agriculture during last three decades has stressed these resources. Degrading quality of natural resource base is threatening the quality aspect of agricultural produce. Climate change and environmental degradation (including important natural resources viz. Land, water, biodiversity) is being considered as one of the greatest risk to future world food security especially in African and Asian continents including India. Agricultural development will have to be therefore guided not only by the compulsion of improving food and nutritional security, but also by the concerns for eco-restoration including conservation and harnessing of biodiversity, long-term sustainability and profitability under the pressure of global climate change scenario. Unsustainable management of natural resources and environment systems is already having serious repercussions, as is evident from several visible signs, particularly in the developing world. Thus, agriculture and allied sector has a critical role in ensuring food security, reducing poverty and sustaining growth in India in this changing scenario. To improve productivity in agriculture, the focus has been on the improvement of efficiency of critical inputs like irrigation, seeds, fertilisers and mechanization. Recently, there have been enormous innovations in agricultural production, not only for improving productivity, but just as importantly, safe guarding the environment. Several systems-research tools relating to information technology have become available for fertilizer management. With the introduction of geographic information systems (GIS), global positioning systems (GPS) and remote sensing (RS), farmers can now refine nutrient recommendation and water management models to the site-specific conditions of each field.

Innovations in efficient Input Resources Utilisation:

Site-specific input management which is based on the spatially and temporally variable conditions, have proved tangible yield gain, along with higher efficiency, profits and better soil health. Precision farming technologies have now been developed to spatially vary nutrients within a field based on various information sources (soil properties maps, terrain attributes, remote sensing, yield maps, etc.). Precision agriculture involves the integration of the modern technologies (including GIS, GPS and RS) to allow farm producers to manage within field variability to maximize the benefit-cost ratio. Variable rate technology (VRT) available with farm implements, such as fertilizer applicators and yield monitors, has evolved rapidly and has fostered the growth of precision agriculture.

Site-specific Nutrient Management (SSNM):

Integration of SSNM with GIS based spatial variability mapping is much more useful technique as it provides an opportunity to assess variability in the distribution of native nutrients and other yield limiting/improving soil parameters across a large area and thus aids in developing appropriate nutrient management strategies leading to better yield and environmental protection. With GIS technology, homogenous fertility management zones are identified and based on different fertility parameters classified into low, medium and high categories using the user defined ranges. Based on the developed homogenous fertility zones, the fertilizer recommendations can be developed for its practical significance for farmers.

Real-time Nitrogen supply:

Synchronization between crop Nitrogen demand and the available N supply is an important key to improve N-use efficiency. Crop N requirements are closely related to yield levels, which in turn are sensitive to climate, particularly solar radiation and the supply of nutrients and crop management practices. The LCC strategy, which has been calibrated with SPAD, is a simple and efficient way of managing N in real time. However, this requires the determination of critical LCC values for a group of varieties exhibiting similar plant type and growth duration (e.g. traditional long duration, semi-dwarf short duration, hybrid etc.). Once the critical values for different varietal groups are determined, they are valid for similar groups of varieties grown elsewhere in the tropics.

Use Decision Support System (DSS):

Use of software based skills like- Nutrient Experts, Crop manager, Geographical Information System (GIS) and Global Positioning System (GPS) in monitoring and application of nutrients, Integrated use of decision support tool (Nutrient Expert®, NE) and Green Seeker (GS) was studied on nitrogen use efficiency (NUE) in wheat, system productivity and economics of maize-wheat system.

Improving water productivity:

Water productivity defined as the output of goods derived from the unit volume of water. The productivity of water irrespective of environment will be governed by those factors which minimize the water losses from the soil system and improve the transpiration water use by the crops. The alternatives for increasing water productivity are changing of crop varieties, crop substitution, deficit, supplemental and precision irrigation, improved water management practices and improving non-water inputs. However, under all situations, the productivity of water could be enhanced either by saving of water use by cutting of non-productive water loss or by increasing the productivity per unit process depletion (crop transpiration in agriculture) or other beneficial depletion and by allocation of water to higher value uses. Reallocation of water from low value to higher value uses would generally not help in any direct water savings but may increase the economic productivity of water. In north India, harvested rain water in farm ponds, may be used as a pre-sowing/life saving irrigation in rainfed crops to improve productivity of water. In central India, harvested rain water not only improve the productivity of current monsoon season crops, but also increase the chances of changing the mono-cropped system to double cropping system. On individual farms, higher water productivity requires selection of appropriate crops and cultivars and proper soil and water management technology, improved planting methods. Pressure irrigation system along with fertilizer application (fertigation) resulted in remarkably high-water use efficiency and yield and thus high productivity of water. Proper combination of water and fertilizers up to optimum level maintaines improved plant water status, physiological functions and higher productivity.

Sustained adoption of Micro-irrigation:

Micro-irrigation technologies are promoted in India by Central and State governments and other organizations with various financial, institutional and technical support. Despite these efforts and economic gains, micro-irrigation area in India remains insignificant proportion of its potential. A study by International Water Management Institute (IWMI) in Maharashtra and Gujarat indicated that the most important determinants of micro-irrigation adoption include access to groundwater, the prevailing cropping pattern, level of education, financial resources, the social stratum of the household, and the wealth or poverty status of the farmer. Further, the impact of micro-irrigation systems on the long-term sustainability of groundwater resources depends on the magnitude of the overall productivity gain following the shift from surface irrigation to micro-irrigation and the behaviour of the adopters. Subsurface drip is a highly efficient irrigation system that uses buried drip tubes or drip tape to meet crop water needs. Since the water is applied below the soil surface (as opposed to surface irrigation or traditional drip irrigation), the effects of surface infiltration, such as crusting, saturated condition of ponding water, and water losses via evaporation and surface run-off (including soil erosion) are eliminated. With an appropriately sized and well-maintained sub-surface drip irrigation system, water application is highly efficient and uniform. Wetting occurs around the tube and water moves out in all directions. Moreover, water is applied directly to the root zone of the crop as opposed to the soil surface where most weed seeds hibernate. As a result, germination of annual weed is reduced. This lowers the pressure on valuable crops. Furthermore, some crops may benefit from the additional heat provided by dry surface conditions, and produce more biomass. When managed properly the application of fertiliser can be optimised. Fields can still be worked when irrigation systems are installed.

Nanotechnology :

Sustainable agriculture can stand to benefit from the application of nanotechnology which has gained momentum to mitigate biotic and abiotic stress as well as other constraints causing low crop yields. The unique characteristics of Nano materials makes them suitable for the design and development of novel tools to support sustainable agriculture. Some of the main applications of nanotools are schematically described as below:

- Increase productivity using Nano-pesticides & Nano-fertilizers e.g. Nano zinc particles.
- Improves soil quality using Nano-zeolites and hydrogels.
- Stimulate plant growth with nanomaterials (e.g. SiO2, TiO2, and carbon nano-tubes)
- Provide smart monitoring using Nano-sensors by wireless communication devices.

As always, for the unexpected severe weather events where science and technology has yet to find a solution to mitigate.

System based technologies for increasing resource use efficiency

Crop diversification:

In general, crop diversification refers to the shift from the regional or temporal dominance of one crop to production of a number of crops, to meet ever increasing demand for cereals pulses, vegetables, fruits, oilseeds, fibers, fodder and fuel, etc. Thus, crop diversification is not only a shift from traditional and less remunerative crops to more remunerative crops, but it is a demand driven, need based situation specific and national goal seeking continuous and dynamic concept and involves spatial, temporal, value addition and resource complementary approaches. So, crop diversification has become an important option to attain the following goals:

- Natural resources sustainability.
- Ecological balance.
- Employment generation.
- Output growth and adequate buffer stocks.
- Risk coverage and reducing the magnitude of risk due to mono-cropping.
- Higher profitability.
- Resilience/stability in production.
- Attaining self-sufficiency in some crops and earning foreign exchange from others.

Crop diversification is two types, first one is horizontal diversification which includes the diversification through crop substitution and crop intensification. Here, diversification takes place through crop intensification by adding new high-value crops to existing cropping systems or to suit the defined objective like use of gap between two crops, utilizes the space available in fields or bunds, as a way to improve the overall productivity of a farm

or region's farming economy. Second one is vertical diversification approach in which farmers and others add value to products through processing, regional branding, packaging, merchandizing, or other efforts to enhance the marketable access of the product.

Integrated Farming Systems:

One of the best approaches in building farm resilience is through spreading risks and creating buffers, i.e. not putting 'all fruits in one basket'. The farming systems approach is considered as important and relevant, especially for the small and marginal farmers as location-specific IFS will be more resilient and adaptive to climate variability. Integration of livestock rearing with crop production gave higher economic returns compared to crop production alone for both marginal and small farmers. On-station and on-farm research in different regions of the country has resulted in identification of many sustainable and profitable IFS models for rainfed areas. In general, in regions with rainfall of 500 to 700 mm, the farming systems should be based on livestock with promotion of low-water requiring grasses, trees and bushes to meet fodder, fuel and timber requirements of the farmers. In 700 to 1,100 mm rainfall regions, crops, horticulture and livestock-based farming systems can be adopted depending on the soil type and the marketability factors. Runoff harvesting is a major component in this region in the watershed-based farming system. In areas where the rainfall is more than 1,100 mm, IFS module integrating paddy with fisheries is ideal. Under irrigated areas, the following IFS models are most suitable to maintain soil fertility and productivity.

Conservation Agriculture (CA):

Conservation agriculture refers to the system of raising crops without tilling the soil while retaining crop residues on the soil surface. Land preparation through precision land levelling and bed and furrow configuration for planting crops further enables improved resource management. Conservation agriculture permits management of soils for agricultural production without excessively disturbing the soil, while protecting it from the processes that contribute to degradation, e.g. erosion, compaction, aggregate breakdown, loss in organic matter, leaching of nutrients etc. Thus, CA is a concept for optimizing crop yield, economics and environmental benefits. Three key features of conservation agriculture are: i.) Minimum soil disturbance by adopting no-tillage and reduced traffic for agricultural operations, ii.) Maximum soil covers by leaving and managing the crop residues on the soil surface, as cover/mulch and iii.) Adopt spatial and temporal crop sequencing/ crop rotation to derive maximum benefits from inputs and minimize adverse environmental impacts. The main advantages of CA are reduction in cost of production, reduced incidence of weeds, saving in water and nutrients, increased yields, environmental benefits, crop diversification opportunities, improvement in resource-use efficiency, etc. The CA practices include laser land levelling, conservation tillage, bed planting, direct-seeded rice, brown manuring with Sesbania, crop residue management and crop diversification.

Climate Smart Cropping:

In changing climate scenario, developing cultivars resistant to climate change may become important adaptive mechanism for maximizing resource-use efficiency. For example, crop varieties those are resistant to lodging (e.g., short rice cultivars), may withstand strong winds during the sensitive stage of crop growth, are viable alternative. Similarly, change of planting dates to minimize the effect of temperature increase and reducing spikelet sterility can be used to enhance yield stability, by avoiding the flowering period to coincide with the hottest period. Such adaptation measures like change in crop calendar to reduce the negative effects of increased climatic variability in arid and semi-arid tropics proved advantageous to avoid extreme weather events (e.g. typhoons and storms) during the growing season.

Integrated Crop Management (ICM):

ICM suggests the use of good agricultural practices (GAP) which is an alternative system of crop production, which conserves and enhances natural resources while producing quality food on an economically viable and sustainable foundation. It combines the best of traditional methods with appropriate modern technology for balancing the economic production of crops with positive environmental management. ICM is particularly beneficial for small and marginal farmers because it aims to minimize dependence on purchased inputs while utilizing on-farm resources.

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TECHNOLOGY INTERVENTIONS IN SANITATION

Sujoy Majumdar

Increasing energy needs of the country needs to be met from various sources. The high dependency on oil, mostly imported, means that rising oil prices, due to its cascading effect affects the prices of essential commodities. Work on alternative, non-depleting energy sources is of paramount importance. Management of waste is another national priority due to its impact, if not done scientifically, which can result in huge environmental and health consequences. The possibility of use of waste to generate energy thus becomes a win-win argument, and is thus a priority for a country like India with high waste, especially bio-waste, production. India has thus to continuously strive and innovate on the use of waste to create cheap and acceptable energy sources.

The Swachh Bharat Mission, launched in 2014, is a unique programme that has brought focus on the cleaning up of our cities and villages, in addition to the elimination of open defecation. As India moves towards achievement of universal access to toilets, the issue of Solid Waste Management in both urban and rural areas is getting special attention. Every year, about 55 million tonnes of municipal solid waste (MSW) and 38 billion litres of sewage are generated in the urban areas of India.

Waste can be broadly classified into:

i) Urban/Rural Waste - Municipal Solid Waste, Sewage and Faecal Sludge.
ii) Industrial Waste – Hazardous and non-Hazardous.
iii) Biomass Waste.
iv) Biomedical Waste.

Most often, waste material find their way into land and water bodies without adequate treatment, resulting in the pollution of water sources. Greenhouse gases like methane and carbon dioxide, are emitted which add to the air pollution. These problems can be mitigated by adoption of waste-to-energy technologies that will allow treatment and processing of wastes before their disposal and are environment-friendly. Specifically, organic waste is a resource, which can degrade, resulting in production of energy. This can be used to reduce the quantity of wastes, while generating energy and reducing environmental pollution.

Waste to Energy:

Waste-to-energy (WtE) also called by the term energy-from-waste (EfW) is the process of generating energy in the form of electricity or heat from the primary treatment of waste material. It is thus the processing of waste into a fuel source and

is a form of energy recovery [http://nwbiorenew.com/Technologies.htm]

The history of waste recovery can be traced back to the first incinerator built in Nottingham, UK in 1874. Though some processes like gasification and pyrolysis have been used for long, technologies for processing solid mixed waste have been developed in recent years as interest on efficient energy recover increases.

Incineration:

Incineration, the combustion of organic material with energy recovery is the most common *Waste to Energy* method. Incineration to convert municipal solid waste (MSW) is a relatively old method and entails burning waste to boil water, which powers steam generators that generate electric energy and heat to be used where required. These processes need to meet strict emission standards, including those on nitrogen oxides (NO_x), Sulphur dioxide (SO_2), heavy metals and dioxins. Further, emission of fine particulate, heavy metals, trace dioxin and acid gas, and proper management of residues like toxic fly ash, are matters of concern that have to be handled properly.

Modern incinerators reduce the volume of the original waste by 95-96 per cent, depending upon composition and degree of recovery of materials such as metals from the ash for recycling.[http://www.zmag.dk/showmag.php?mid=wsdps]. There are arguments that incinerators destroy valuable resources and reduce incentives for recycling, however use of incinerators in many places is often done to avoid landfilling.

Other technologies:

There are many other new and emerging technologies that have the potential to produce more electric power from the same amount of fuel than would be possible by direct combustion. This is mainly due to the separation of corrosive components (ash) from the converted fuel, thereby allowing higher combustion temperatures in e.g. boilers, gas turbines. Some can efficiently convert the energy into liquid or gaseous fuels. These technologies include the following:

- **Thermal Technologies**:
- **Gasification:** producing combustible gas, hydrogen, synthetic fuels.
- **Thermal depolymerization:** producing synthetic crude oil, which can be further refined.
- **Pyrolysis:** producing combustible tar/bio-oil and chars.
- **Plasma arc gasification or plasma gasification process (PGP):** producing syngas including hydrogen and carbon monoxide usable for fuel cells or generating electricity and other products.
- **Non-Thermal Technologies:**
- **Anaerobic digestion:** producing Biogas rich in methane
- **Fermentation production:** Takes biomass and creates ethanol, using waste cellulosic or organic material. e.g. ethanol, lactic acid, hydrogen.
- **Esterification** - the result of this process is biodiesel. The cost effectiveness of esterification will depend on the feedstock being used, and other relevant factors such as transportation distance, amount of oil present in the feedstock, etc.
- Mechanical biological treatment (MBT).

In thermal technologies, nearly all the carbon content in the waste is emitted as carbon dioxide (CO_2) to the atmosphere. Further, nearly all biodegradable waste is biomass. That is, it has biological origin. This material has been formed by plants using atmospheric CO_2. These are the main reason why countries deal with the biomass part of waste as renewable energy. The rest i.e. mainly plastics and other oil and gas derived products are generally treated as non-renewables.

India: Waste to Energy Potential

The Indian Government has recognized waste to energy as a renewable technology and supports

it through various subsidies and incentives. The Ministry of New and Renewable Energy (MNRE), is actively promoting technology options available for energy recovery from urban and industrial wastes. MNRE is also promoting the research on waste to energy by providing financial support for R&D projects on cost sharing basis. MNRE also provides financial support for projects involving applied R&D and studies on resource assessment, technology up-gradation and performance evaluation.

According to the MNRE, there exists a potential of about 1700 MW from urban waste (1500 from MSW and 225 MW from sewage) and about 1300 MW from industrial waste. The government is also actively promoting the generation of energy from waste, by providing subsidies and incentives for the projects. Indian Renewable Energy Development Agency (IREDA) estimates indicate that India has so far realized only about 2% of its waste-to-energy potential.

To promote biofuels in the country, a **National Policy on Biofuels, revised in 2018**, highlights its strategic importance as it converges well with the other important initiatives such as Make in India, Swachh Bharat Mission, Skill Development and offers possibilities to integrate other programmes of doubling of Farmers Income, Import Reduction, Employment Generation, and promoting Waste to Wealth. The policy has the objective of reaching 20 per cent ethanol blending and 5 per cent biodiesel blending by 2030. Among other things, the policy expands the scope of feedstock for ethanol production and has provided for incentives to produce advanced biofuels. However, the need for sustained and quantum availability of domestic feedstock for biofuel production must be addressed. Some of the other innovative initiatives seen are the setting up of a plant to convert plastic waste into bio-diesel to be made operational at the Indian Institute of Petroleum (IIP) in Dehradun. The plant has the capacity to convert one ton of plastic waste into 800 litres biofuel which will be of highest quality and it can be used in any diesel automotive vehicle.

Gobardhan:

As a part of Swachh Bharat Mission, the Government launched the GOBAR-DHAN - 'Galvanizing Organic Bio-Agro Resources Dhan' scheme in Feb 2018. This initiative of the Ministry of Drinking Water and Sanitation, aims to support biodegradable waste recovery and conversion of waste into resources. This aims to support, the creation of clean villages which is the objective of Swachh Bharat Mission (Gramin), and provide economic and resource benefits to farmers and households. The GOBAR-DHAN scheme will engage with people in the safe and efficient management of solid waste, especially the bio-agro waste in villages, so that the villages remain clean. The GOBAR-DHAN scheme is a crucial component of the ODF Plus (Open defecation free plus) strategy of SBM(G) and will focus on supporting villages in management of bio-waste.

Presently, a very large fraction of bio-waste gets disposed in unsafe ways – burning, unscientific dumping, discharging into water bodies, etc. On the other hand, bio-resources such as animal dung cakes, crop residue and firewood are commonly used as cooking fuel leading to indoor air pollution which is considered responsible for a significant number of acute respiratory illnesses in young children. So, bio-waste has the potential to be harnessed as energy, fuel, and fertilizer. Waste such as cattle dung, poultry droppings, pig excreta, human excreta, crops & crop residues, kitchen waste etc., can produce biogas, through anaerobic

digestion and produce clean fuel for cooking, lighting, electricity, running biogas based engines, etc. Rural India generates enormous quantities of bio-waste including animal waste, kitchen leftovers, crop residue, market waste and faecal sludge. According to 19th Livestock Census of India, 2012, there are about 300 million bovines, 65.07 million sheep, 135.2 million goats and about 10.3 million pigs. At least 5,257 tonnes waste/ day is estimated to be generated from livestock alone. In addition, according to Indian Agricultural Research Institute's estimates in 2014, India generated 620 million tonnes of crop residue, of which 300 million tonnes are treated as waste and 100 million tonnes are burnt on farms.

GOBAR-DHAN scheme proposes to cover 700 projects across the country in 2018-19 with upto Rs. 10 lakhs available per GP. Eleven schemes under GOBARDHAN are in the process of being set up. [Ministry of Drinking Water and Sanitation 2018]

Plastic Waste :

Everyday, about 15,000 tonnes of plastic waste are generated across India, of which, 60% is recycled and 40% is disposed unsafely finding its way into drains, oceans, dumping grounds, open burning, and even inside the body of many living creatures. Some low-quality plastics very commonly used in rural areas also leach out toxic additives, polluting the soil and water resources. The open burning of plastics generates toxic emissions including carcinogenic compounds such as dioxins. There is an urgent need for attention on the management of plastic waste.

Extended Producer Responsibility (EPR):

Under this concept. the manufacturers and importers of products are to bear a significant degree of responsibility for the environmental impacts of their products throughout the product life-cycle, including upstream impacts inherent in the selection of materials for the products, impacts from manufacturers' production process itself, and downstream impacts from the use and disposal of the products. The Indian 2016 Plastic Waste Management Rules also address the question of extended producer responsibility (EPR). They mandate plastic producers, importers and brand owners to contribute to the collection of plastic waste that is introduced by them.

Technology for managing Plastic Waste:

There are 4 main ways of managing plastic waste:

- Re-extrusion: This category of management systems involves the introduction of clean scrap of single types of plastics that can be re-entered into manufacturing processes to produce similar materials.
- Mechanical Recycling: This category includes the variety of mechanical processes performed on plastic waste, before it is introduced in manufacturing processes.
- Chemical and Thermal Recycling: Chemical recycling uses advanced technical processes that convert plastic materials into smaller constituent molecules which can then be used as feedstock to produce petrochemicals and plastics.
- Energy Recovery: The various methods under this category burn plastic to produce energy in the form of heat, steam and electricity.

There are efforts now in the above direction. Some examples of use of plastic waste in India:

i. Plastics for road construction- More than 1200 kms of plastic waste mixed roads in rural areas have been laid by DRDA, Erode Tamil Nadu.

ii. Waste to fuel plant in Sriperumbudur in Tamil Nadu run by Paterson Energy. The plant sources plastic waste from nearby automobile industries and paper manufacturers to run a plant at a capacity of 7.5 tonnes/day.

[Ministry of Drinking Water and Sanitation 2018]

Conclusion:

Increasing energy needs of the country need to be met from various sources. The high dependency on oil, mostly imported, means that rising oil prices, due to its cascading effect affects the prices of essential commodities. Work on alternative, non-depleting energy sources is of paramount importance. Management of waste is another national priority due to its impact, if not done scientifically, which can result in huge environmental and health consequences. The possibility of use of waste to generate energy thus becomes a win-win argument, and is thus a priority for a country like India with high waste, especially bio-waste, production. India has thus to continuously strive and innovate on the use of waste to create cheap and acceptable energy sources.

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DISEASE MANAGEMENT IN HORTICULTURAL CROPS

Dr H.R. Gautam

Demand for eco-friendly bio-pesticides and other methods in disease management is gaining momentum from the fact that slowly we are going towards organic production of crops which need alternative approaches of crop protection. There are number of alternative approaches like botanical pesticides, bio-pesticides, plant resistance, manipulation of cultural practices, use of organic amendments, use of physical approaches like soil solarisation and modern molecular techniques of developing transgenic.In addition, tapping the potential of resistance sources through bio-technological tools have also been effectively used for the management of plant diseases.

Food and Agriculture Organization (FAO) of the United Nations estimates that pests i.e. insects, weeds, plant diseases, rodents and birds cause up to 35 percent of the losses in the crop production worldwide, annually. When losses due to pests are combined with postharvest losses, worldwide food losses would amount to 45 percent. Chemical fungicides and fertilizers have contributed in a major way to boost the crop productivity and production to make India self sufficient in food grain production. However, the use of chemicals in farming finds its way to the environment which creates lot of problems. It is reported that less than 0.1 per cent of pesticide sprayed reaches the sites of action, due to loss of pesticide in air during application and as run-off, spray drift, off-target deposition and photo degradation affecting both the environment and application costs. It is estimated that approximately 1.8 billion people are engaged in agriculture and most use pesticides to protect food and commercial products that they produce. Worldwide, 4.6 million tonnes of chemical pesticides are sprayed into the environment every year. Developing countries account for 25 percent of world pesticide use in farming, but account for 99 percent of the world's deaths due to pesticides. Recent estimates indicate that the economic impact of pesticides on non-target species (including humans) is approximately $8 billion annually in developing countries. About 25 million agricultural workers experience unintentional pesticide poisonings each year around the world. Indiscriminate use of chemical pesticides compounds the problem further and adversely affects the other biotic life like animals, birds, aquatic life and soil micro-flora which endanger our bio-diversity.

In India, according to a report of the Ministry of Agriculture, residues of chemical pesticides were

detected in 9.2 percent of the samples of different food articles collected between 2006 and 2012, out of which 1.5 percent of the samples contained residues above maximum permissible level. Use of these costly chemical pesticides has also resulted in higher cost of production of the farm produce. Thus, there is a need to promote the use of eco-friendly methods of disease management in our crops to make farming eco-friendly so that the agriculture produce is safe for the use of the consumers. Demand for eco-friendly bio-pesticides and other methods in disease management is gaining momentum from the fact that slowly we are going towards organic production of crops which need alternative approaches of crop protection. There are number of alternative approaches like botanical pesticides, bio-pesticides, plant resistance, manipulation of cultural practices, use of organic amendments, use of physical approaches like soil solarisation and modern molecular techniques of developing transgenic. In addition, tapping the potential of resistance sources through bio-technological tools have also been effectively used for the management of plant diseases. Nano-formulations of pesticides also have great promise in future to develop safer and green fungicides.

Bio-pesticides:

Microbial pesticides are products derived from various microorganisms (e.g., bacterium, fungus, virus or protozoan) that are used as an active ingredient to control pests. Almost 90 per cent of the microbial biopesticides currently available in the market are derived from only one pathogenic bacterium i.e. *Bacillus thuringiensis* or Bt which is used against insect-pests. B. thuringiensis-based biopesticides are an effective tool against lepidopterans insects. In plant disease management, *Trichoderma* spp. are the most widely used microbial biopesticide. Agrobacterium radiobacter K1026 is used against crown gall disease worldover. Various species of *Trichoderma* have been developed in different formulations and are being used in the management of diseases of agricultural and horticultural crops. One of the most successful examples of microbial biopesticide use is in the management of diamondback moth (*Plutella xylostella*) which is the most destructive insect pest on Brassicas vegetables in tropical Asia and Africa. Against diseases of vegetable crops, the major microbial biopesticides used are *Trichoderma viride*, *T. harzianum*, *Pseudomonas fluorescens* and *Bacillus subtilis*. These microbial biopesticides are mostly used against damping off, root rot and collar rot diseases in most of the vegetable, horticultural and ornamental crops.

Currently, biopesticides comprise a small share of the total crop protection market globally, with a

value of about $3 billion worldwide, accounting for just 5 per cent of the total crop protection market. According to the figures from BPIA (Bio-Pesticides Industry Alliance), the world market for biopesticides grew at a double-digit rate (10%) from USD 670 million to USD 1 billion, between 2005 and 2010. Further, between 2010-11 and 2016-17, usage of bio-pesticides increased by 23 per cent, while that of chemical pesticides grew only by 2 per cent. Data from the Directorate of Plant Protection, Quarantine & Storage, Ministry of Agriculture & Farmers Welfare, indicate that in 2010-11, the all-India consumption of bio-pesticide was 5,151 tonnes, which has increased to 6,340 tonnes for 2016-17. Bio-pesticides market in India, generated revenue of $102 Million in 2016 and is anticipated to contribute $778 Million by 2025, growing at a CAGR of 25.4 per cent. The demand for bio-pesticides is bound to increase as it is an important component of organic farming. Globally, there were more than 430 registered bio-pesticide active ingredients and 1320 active product registrations in 2014.

Botanical Pesticides:

Nature has provided us with vast treasure of plant species and other local bio-resources which can be used for the management of diseases and pests in different crops. Botanicals with antifungal compounds have been identified and these can be exploited for the management of diseases. Botanicals have low mammalian toxicity, target specificity, biodegradability and contain many active ingredients in low concentrations, thus possess biocidal activity against several insect pests and pathogens. Among such plants, neem is one of the most important trees which have a great potential for disease and insect-pest management in India and other parts of the world. This single tree has such potential that it can meet more than 50 per cent requirement of our pesticides in crop production. India has more than 18 million trees of neem with seed potential of 4,14,000 tonnes which can yield 85,000 tonnes of oil and 3,30,000 tonnes of oilcakes. Neem pesticides have been reported to control more than 200 species of insect-pests, nematodes and also effective against more than 50 diseases. Neem contains at least 35 biologically active ingredients of which triterpenoides, nimbin, azadirachtin are present predominantly in the seeds, leaves and other parts of the plant.

Soil Solarization:

It is an effective method to control soil-borne pathogens. Soil solarization is done by covering the moistened soil in summer months with thin transparent polyethylene mulch for capturing solar energy for heating the soil, which becomes lethal to the soil-borne pathogen. Soil solarization is an effective method to control soil-borne pathogens in different soil-ecosystems and crops. Generally, a layer of thin transparent polyethylene (25-50 µm) is applied to the soil surface prior to planting and the mulch is left in place for 4 to 6 weeks during the hot season in the appropriate climatic region. The heat generated

in the soil due to increase in soil temperature acts as a lethal agent in controlling or inactivating soil-borne pathogens in soil. On an average, one square centimeter area outside the earth's atmosphere and parallel to its surface receives 2 colories/cm^2/minute of energy in the form of solar radiation but only half of it finally reaches the ground. Soil solarization is effective in reducing the incidence of many soil-borne diseases in different crops causing wilts and root rots. Bio-fumigation is another effective method of using the local bio-resources available in the field to the disadvantage of the plant pathogens. It is the process of growing, macerating / incorporating certain Brassica or related species into the soil, leading to the release of isothiocyanate compounds through the hydrolysis of glucosinolate compounds contained in the plant tissues. Incorporation of the crop residues of cabbage, cauliflower, mustard or other crops of Brassica family should be done before the covering of the soil with the transparent polyethylene mulch. This practice results in suppressing the growth of range of soil-borne pests and diseases. Bio-fumigation can be integrated with soil solarisation and it result in synergistic effect in the management of the soil-borne diseases.

Biotechnological Approaches :

Biotechnology is proving to be important tool in plant pathology in understanding the host, pathogen and the process of pathogenesis, thus opening new avenues for management of the diseases. Biotechnology has helped us in unravelling the complexity of plant and pathogen genomes, understanding relationship among pathogen populations, pathogen evolution, molecular taxonomy, understanding structure and function of resistance and avirulence genes, elucidating mechanisms of host pathogen interaction and development of disease resistant crops. Recently, two new technologies have emerged which seems to revolutionize the management of plant diseases e.g. miRNA based disease management and development of genome edited crops using CRISPR/cas system. The biotechnological tools such as genetically modified crops which were earlier not accepted primarily by the public, are finding increased acceptance in the world. This is probably because release of crop with transgenes is tightly regulated leaving little fear in the mind of public. A report from the International Service for the Acquisition of Agri-Biotech Applications (ISAAA) said that farmers who planted biotech crops have reduced pesticide spraying. One of the major game changers for biological pesticides discoveries was the advent of 'Omics' technologies. The traditional microbiological techniques that were utilised in the 20th century did not allow for a high throughput screening of organisms. 'Omics' technologies have allowed us to profile the microbial communities living inside and outside of plants and better understand the complex plant-microbe and microbe-microbe interactions and their biological functions. These new technologies can reveal in a high throughput capacity taxa, genes, metabolites or proteins that have potential antimicrobial attributes.

Changes in Crop Growing Practices:

Different **c**ultural practices are done during the cropping period and slight modifications/ alterations can be effectively used to the disadvantage of many plant pathogens. Cultural practices are modified in a way so that the yield and productivity of the crops is not affected. In these practices, either contact of the pathogen with the crop is avoided/ minimized or disease cycle of the pathogen is interrupted. This can be done in the absence of the host, at planting, during plant growth and afterwards by manipulating the biotic and abiotic environments. In cultural practices, planting date, irrigation and ploughing can be easily adjusted to escape or avoid disease. Cultural practices that promote soil health include crop rotation, use of crop residues and green manures or organic amendments. Use of soil amendments and green manures promote soil health which helps in greater biological suppression of pathogens. Cultural practices such as exclusion, eradication and sanitation are effective against different crop diseases such as apple scab, citrus canker, pre-mature leaf fall of apple and many other diseases. Incorporation of organic matter in the soil is generally considered to have a beneficially effect on the texture of all type of soils. Crop rotation is one of the important methods to reduce the inoculums load of the pathogens in soil and then making it one of the most important methods of management of soil-borne plant pathogens. Crop rotation should be a regular practice in intensive cropping in open field and protected cultivation in polyhouses and greenhouse. The frequency of the crop rotation can be 2 to 3 years.

Deep ploughing is another method in cultural practices which affect the survival of plant pathogens as many plant pathogens are oxygen loving and deep ploughing result in the inactivation or death of the pathogen propagules. Flooding of the field also help to the disadvantage of many plant pathogens and the harmful effect on soil-borne pests may be related to lack of O_2, increased CO_2 or various microbial activities under anaerobic conditions, e.g. production of substances that are toxic to the pathogen. Sanitation of the field, orchards or polyhouses can also help to reduce the incidence and severity of all those diseases where the pathogen is harbouring in the crop residue.

Use of Resistant Varieties of the Crops:

Plant is endowed with capacity to defend itself against pathogen and the task before the breeders is to bring that potential to the frontline of commercial cultivars. As wheat is a major food grain in India and many other countries, scientists rely mainly on resistance sources to manage rusts and smut diseases with success. In stem rust of wheat, the threat of new race Ug 99 is looming large but resistance sources have already been screened to counter the menace. Use of host plant resistance is most effective, economical and eco-friendly tool of disease management. Since then, plant breeders have made major successes in developing varieties with higher level of resistance to major diseases in several crop plants. Today, Bt cotton is the most important tool which has resulted in considerable reduction in the use of chemical pesticides in agriculture. There are various tools and approaches to use the host plant resistance like gene pyramiding, gene deployment, multilines, sequential releases, varietal mixtures, composite like strains. Now we have recent genomic, bio-informatics and molecular biology techniques and it is possible to tame the R-genes for incorporating resistance against diseases. Plant disease resistance has been used successfully to breed varieties against important diseases of crops like potato, tomato, capsicum, apple, rice, sugar cane, citrus, banana, papaya, coconut, coffee and many other diseases of economic importance.

Nano-formulations of Pesticides:

Nanotechnology has opened new avenues in plant disease management as these are safer in comparison to chemical pesticides and more effective at very low dosages. Process of green synthesis of nano-particles has made them more eco-friendly and economic. Different type of materials can be used for the synthesis of nano-particles. Among all, plant extract based silver nanoparticles (SNPs) have good potential for the management of various diseases in plants. SNPs can be synthesized through application of physical, chemical and biological approaches. Biological approach of synthesis of SNPs using plant extracts is the most adopted eco-friendly approach. This approach has a special advantage as the plants are widely distributed, easily available, much safer to handle and act as a source of several metabolites. Plants also provide a better platform for nano-particle synthesis as they are free from toxic chemicals as well as provide natural capping agents. SNPs have been synthesized from many plants like neem, tulsi etc. Nanoparticles are effective in protecting neem oil from rapid degradation, allowing a prolonged effect on target pests. Nano-formulations can provide controlled release of the molecules at the site of action, can minimize potential toxic effects on non-target organisms, and can prevent degradation of the active agent by microorganisms. Antimicrobial effect of nano-particle has been attributed due to their small size and high surface to volume ratio which allow them to closely interact with microbial membrane, causing its rupturing and killing of pathogens. Commercialization of nano-

formulations of fungicides is also taking place as research in this area is advancing. Some major agro-chemical companies like Bayer Crop Science, Monsanto and Syngenta are engaged in making of nano-formulation of fungicides.

Scope of Bio-pesticides:

The use of biopesticides in agriculture is fully aligned with market trends that promote healthy eating without neglecting environmental conservation. Consumers are increasingly demanding residue-free food. The trend is becoming more and more powerful. There are figures confirming it in various parts of the world. Organic agriculture is practiced in 172 countries around the world and 43.7 million hectares of agricultural land are managed organically by approximately 2.3 million farmers. The global sales of organic food and drink reached 80 billion US dollars in 2014. Australia is the country with the largest organic agricultural area (17.2 million hectares, with 97 per cent of that area used for grazing), followed by Argentina (3.1 million hectares) and the United States of America (2.2 million hectares). In India, area under certified cultivable organic farming has increased to 1.49 million ha with production of around 1.35 million metric tonnes which will have tremendous requirement of different organic inputs. There is tremendous demand for the organic produce in India and abroad. According to the U.S. Department of Agriculture's National Agricultural Statistics Service, US farms produced and sold $7.6 billion in certified organic commodities which was 23 per cent more than the previous year. As a result, there has been 11 per cent increase of organic farms in 2016 and a total acreage reached to 5 million acres, up 15 per cent from 2015. In 2016, Spain surpassed the figure of two million hectares dedicated to organic farming, registering an increase of 8.5 per cent than in 2015. According to Eurostat data, between 2012 and 2016, the area under organic farming grew by 18.7 per cent in the European Union. In 2009, the European Union voted a directive to phase-out a number of chemical pesticides in agriculture and governments of Sweden, Denmark and the Netherlands took the lead to announce measures for 50 per cent reduction in on-farm chemical pesticide use. France has also taken initiative to halve the consumption of pesticides in agriculture by 2025. India needs to take lead by mix of initiatives may be in the form of gradual reduction of toxic chemicals and by incentivising the production and use of bio-pesticides to promote chemical free farming.

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Swachh Bharat Mission leads Countrywide World Toilet Day Celebrations

The World Toilet Day was celebrated on 19th November, 2018, by people from across the country with mass awareness and mobilization activities. The focus was on usage of toilets, which is closely linked to the Prime Minister's call for a Swachh Bharat by October 2019.

The Prime Minister Shri Narendra Modi reiterated the country's commitment towards enhancing cleanliness and sanitation facilities. He said, "We in India take pride at the remarkable speed with which sanitation cover has increased in the last four years."

The Swachh Bharat World Toilet Day Contest organized by the Ministry of Drinking Water and Sanitation also culminated with massive community activities across States and districts. School children, health workers and Anganwadi workers and common people came out in large numbers on World Toilet Day to reaffirm their commitment to keep their villages open defecation free. Men, women and children took Swachhta oaths; school children marched through villages and performed plays spreading the message of Swachhta; videos and other demonstrations were shown on the use of twin pit technology; mass hand washing drives were taken up and Swachhta champions were awarded and recognized. The Districts and States who have taken the best set of initiatives during the World Toilet Day will be awarded by the MDWS at national level.

TECHNOLOGY INNOVATIONS FOR SOIL HEALTH PRESERVATION

Anjani Kumar

Preserving soil health is vital to human health, ecosystem functions and nature conservation. Soil health is a burning global issue now than ever before. Its management is vital to ensuring food and nutritional security, preserving soil biodiversity, enhancing use efficiency of inputs, and mitigating global warming potential. Integration of governmental and non-governmental bodies are needed for successful implementation of the soil health restoration and preservation initiatives.

The definition of soil differs from the view point of geologists, pedologists, agrochemists, agronomists, ecologists, microbiologists and other scientists. It is examined from different aspects, often using the same or similar methods, with different goals and tasks implemented.

Soil is a dynamic system, consisting of organic and mineral matters, air, water and living organisms along with their interactive processes. Soil is formed through a complex process which takes thousands of years to make an inch of soil. It is a natural organo-mineral product formed by natural forces and maintained by the interaction between microorganisms and plants. If managed unscientifically, it can easily be contaminated, eroded and destroyed in a very short span of time. Increasing population and shrinking land resources for agriculture is tremendously increasing pressure on soil beyond the boundaries of sustainability. Our consumerism attitude or greed results in indiscriminate use of fertilizers, pesticides and land resource, which disturbs the harmony existing within the soil thereby affecting the physico-chemical properties of the soil system. Thus, there is a need to understand the soil health and the systems that affect it, so as to devise strategies for its sustainable use for providing the human needs in the future.

Soil Health:

Soil health and soil quality are considered synonymous and can be used interchangeably. However, one key distinction is that soil quality includes both inherent and dynamic quality. The Soil Science Society of America defines soil health '*as the capacity of a specific kind of soil to function, within natural or managed ecosystem boundaries, to sustain plant and animal productivity, maintain or enhance water and air quality, and support human health and habitation*'. Soil health is like animal health where the soil sustains production depending upon the status of soil health attributes.

Soil health concept involves integration of physical, chemical and biological properties of a soil and role of its harmonious blend in sustaining growth, productivity and environmental security. Thus, soil is an ecosystem full of life that needs to be carefully managed to regain and maintain the ability to function optimally. Healthy soils maintain a diverse community of soil organisms that help to control plant disease, insect and weed pests, form beneficial symbiotic associations with plant roots, recycle essential plant nutrients, improve soil structure with positive effects for soil water and nutrient holding capacity, and ultimately improve crop production. A healthy soil also contributes to mitigating climate change by maintaining or increasing its carbon content.

Sustainable Soil Health Management:

A soil that is able to optimally sustain its native/acquired productivity potential and render ecological services is said to be in good health. It is associated with the following characteristics:

- Minimum soil erosion.
- Good soil physical properties.
- Sufficient soil cover.
- Stable soil organic matter.
- Improved soil fertility and productivity.
- Absence of Soil salinization, sodification and alkalinization.
- Absence of soil Contaminants.

Good practices for Soil health preservation:

1) Prevent soil erosion:

Soil erosion causes the loss of top layer soil containing organic and mineral nutrient pools. It is accelerated by anthropogenic activities, reduced plant or residue cover, tillage and other field operations, and reduced soil stability. It should be minimized by growing cover plants. Maintaining organic or inorganic residues also protects soil surface. Several other measures are mulching, minimum tillage, no-till by direct seeding, strip cropping, agroforestry, shelter belts, and reduced stocking rates and grazing intensities.

Table 1. Common Indicators of Soil Health

Chemical Indicators	Physical Indicators	Biological Indicators
Soil pH	Soil texture	Microbial biomass
Soil electrical conductivity	Soil particle and bulk density	Population of soil micro and macro organisms
Organic matter content	Penetration resistance of soil	Soil enzyme activities
Total carbon and nitrogen	Aggregate stability	Pollutant detoxification
Cation exchange capacity	Soil water holdingcapacity	Soil respiration
Soil essential nutrient	Soil aeration and porosity	Soil pathogens
Heavy and toxic metals	Soil infiltration rate	

2) Increase soil organic matter content:

It plays a central role in maintaining soil functions and preventing soil degradation. A loss of soil organic matter due to poor soil management or inappropriate cropping practices can cause a decline in soil quality and soil structure, and increase soil erosion, potentially leading to emissions of carbon into the atmosphere. Innovative practices for increasing organic matter content are: managing crop residues, minimum grazing, practicing organic farming, applying integrated method of soil fertility management and pest management, applying animal manure or other carbon-rich wastes, using compost, and applying mulches or providing the soil with a permanent cover, reduced- orno-tillage practices, Implementing crop rotations etc.

3) Soil Nutrient Balance and Cycles:

It is crucial to select an appropriate plant nutrient management system for sustainable agriculture management. It can be enhanced through nutrient recycling or additions including mineral (chemical) fertilizers, organic fertilizers and other soil amendments including primary sources (e.g. rock phosphate) and secondary sources (e.g. phosphorus from sewage sludge). Enhancing nutrient use efficiency should be done by applying balanced fertilization and/or innovative products (e.g. slow and controlled release fertilizers), precise and judicious use of organic and mineral amendments, inorganic fertilizers, and agricultural by products.

4) Mitigating Soil Salinization and Alkalinization:

Salinization reduces crop yields and, above certain thresholds, completely eliminates crop production. Optimum irrigation management should ensure sufficient water for plant growth and efficient drainage to avoid problems of salinization. Good quality irrigation water should be applied in the fields. Surface and sub-surface drainage systems should be installed and maintained to control groundwater tables and control soil salinity.

5) Minimizing soil contamination:

Contamination occurs if the rate of addition of a given contaminant exceeds its rate of removal from the soil system. Harmful consequences may include plant toxicities and subsequent productivity declines. Contaminated soils should not be used for food and feed production.

6) Conserving soil Biodiversity:

Soil organisms play key roles in the delivery of many ecosystems services. It can be maintained or enhanced through the provision of sufficient vegetative cover (e.g. cover crops, multiple crops), optimal nutrient additions, addition of diverse organic amendments, minimizing soil disturbance, avoiding salinization, and maintaining or restoring vegetation such as hedgerows and shelterbelts. Use of nitrogen fixing leguminous species, microbial inoculants, mycorrhizas, earthworms and other beneficial soil organisms should be encouraged where appropriate.

Technological options for soil health management

Conservation Agriculture	No Till
	Residue mulch
	Integrated nutrient management
	Cover cropping
Farming systems approach	Livestock
	Trees
Degraded land restoration	Salinized land
	Mined land
	Depleted land
Application of Organic amendments	Compost
	Manure
	Biochar

Conclusion:

Hayne (1940) stated that, "if we feed the soil, it will feed us," and that "only productive soil can support a prosperous people." Thus, preserving soil health is vital to human health, ecosystem functions and nature conservation. Soil health is a burning global issue now than ever before. Its management is vital to ensuring food and nutritional security, preserving soil biodiversity, enhancing use efficiency of inputs, and mitigating global warming potential. Integration of governmental and non-governmental bodies are needed for successful implementation of the soil health restoration and preservation initiatives.

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USE OF ICTs IN EDUCATION

Dr Abhay Kumar

The focus of technological integration into the education cannot be different from the central concerns of education which are to improve the quality of education for children, ensuring joyful learning environment for every child of the country; making learning constructive, critical, inclusive and collaborative and finally, building on a lifelong intellectual partnership with technology by constantly reflecting and analysing one's learning.

In the 21st Century, mastering the skills of computers can be considered alongside 3 Rs (Reading, Writing and Arithmetic) as the fundamental requirements for a fully literate person. Whether one agrees with it or not, importance of computers and related technologies in the society is here to stay. One comes across the digital world in myriad ways while performing one's duties and responsibilities in the society. No wonder government has undertaken several initiatives in recent years to augment the digital literacy of its citizens. Various efforts can broadly be categorised as under the following. i) Through formal school education system where in subjects such as Information Technology is offered to students as part of main subjects at secondary level while a subject on Computer Science is offered at the senior secondary level. ii) Through vocational courses on IT under National Skill Qualification Framework (NSQF), which envisages a smooth transition for students from what is considered main subjects to the vocational stream without worrying about certifications or mobility in career. The vast population of India's youth require skills and their upgradation in digital technology. Government of India has invested heavily in skill development of youth by enlisting National Skill Development Corporation (NSDC), Sector Skills Council (SSC), Pandit Sundarlal Sharma Central Institute of Vocational Education (PSSCIVE), National Council of Educational Research and Training (NCERT) and State Governments. iii) Enhancing the technological competencies of teachers during both pre-service and in-service teachers training and iv) creating a digital environment in the country by the massive use of digital technologies in increasing access, enhancing quality of education, ensuring inclusion in the educational systems.

Before proceeding further, it is important to understand what technology means for education. In the enthusiasm for technology, we often miss the focus of our attention, which is education. How technology can be deployed for enhancing the

learning of children or how technology can be used for improving the learning experiences of children are more important than the technology itself. The *Oxford English Dictionary* mentions that technology is "the collection of mechanical arts (which may be defined as methods, practices and devices) that are available to a culture to make its economy and society functions. It is beyond the scope of this article to discuss the 'technology' threadbare. However, in the context of this article, it can safely be stated that a technology which does not achieve a human purpose is not a technology at all. Considering technology to be more than mere hardware, it must fulfill one or more of the human purposes if it claims to be the one. The primary focus of the educational technology (ET) or the usages of Information and Communication Technologies (ICTs) in education remain the learning. The focus of technological integration into the education cannot be different from the central concerns of education which are to improve the quality of education for children, ensuring joyful learning environment for every child of the country; making learning constructive, critical, inclusive and collaborative and finally, building on a lifelong intellectual partnership with technology by constantly reflecting and analysing one's learning.

So, overall technology should be used in providing quality education to 26 crore students studying in 15 lakh schools (66 % under government control) having 85 lakh teachers with majority of schools (close to 84 percent) falling in rural areas of the country. Bridging digital divide in an educational system where already a chasm exists on the basis of gender remains the central concern. In such a context, India's policy initiatives have kept pace with the technological evolution. A journey which began in 1972 in the form of Educational Technology scheme under which 100 % assistance was given to establish 6 State Institutes of Educational Technology (SIETs) and States/UTs were assisted for procuring radio cum cassettes players and colour television sets has travelled a long distance indeed.

The Union Budget, 2018-19, has proposed to start 'Samagra Shiksha' - an overarching programme for the school education sector extending from pre-school to class 12 by subsuming the erstwhile Schemes of Sarva Shiksha Abhiyan (SSA), Rashtriya Madhyamik Shiksha Abhiyan (RMSA) and Teacher Education (TE). The main outcomes of the Scheme are envisaged as Universal Access, Equity and Quality, promoting Vocationalisation of Education and strengthening of Teacher Education Institutions (TEIs). One of the important interventions envisaged under Samagra Shiksha is the Digital Initiatives. It is perhaps the natural corollary of Digital India campaign which sought to revolutionise the digital ecosystem of the country by emphasising on three core components: the development of secure and stable digital infrastructure, delivering government services digitally, and universal digital literacy.

Some of the digital initiatives undertaken at the national level in pursuits of universal access, equity, quality education, vocational education and teacher education are discussed below.

ICT curriculum for students and teachers (ictcurriculum.gov.in) seeks to educate and train students and teachers on the wide implications of use of ICT in education in a flexible manner allowing course participants to choose the timings as per their own conveniences. As its website mentions, "for the teacher, it is an initiation into exploring educational possibilities of technology, learning to make the right choices of hardware, software and ICT interactions, and more importantly, growing to become a critical user of ICT. For the student, it is an initiation into creativity, problem solving, and an introduction to the world of information and technologies which could also shape career pursuits." Some of the states like Andhra Pradesh, Delhi, Tripura and Telangana are in the process of implementing ICT curriculum for students. While state of Karnataka has adopted this curriculum for its teachers.

Development, curation and dissemination of e-content is an ongoing process in which National level institutions are involved and collaborating with other agencies to bring out the best e-contents for the children of this country. All e-contents are

reviewed before putting out for dissemination. Most of the audio/video contents are also available freely on youtube channel.

e-Pathshala

Government of India has launched e-pathshala (epathshala.nic.in) portal and mobile app (for all 3 mobile platforms, viz., android, windows, ios) in 2015. A joint initiative of Ministry of Human Resource Development and NCERT, this portal/app has all the textbooks of NCERT from Class I to XII in digital form (698 e-books as ePubs & 504 flipbooks). There are other e-contents (more than 3000 of audio/video materials) available on this app. All these resource are freely available. More than 35 million users access the contents on web portal of e-pathshala while about 1.8 million users access these contents through app.

National Repository of Open Educational Resources (nroer.gov.in) was launched in 2013. It is a storehouse of all types of e-contents (more than 13000 contents are available now) arranged thematically and mapped according to the NCERT curriculum. More than 30 organisations have joined hands to share their respective e-contents under creative commons license on this repository.

A bouquet of channels (32 DTH TV channels to be precise) was launched by the Hon'ble President of India on 9th July 2017 in New Delhi under the SWAYAM PRABHA initiative. The purpose of this initiative is to telecast high-quality educational programs on these 32 channels on 24x7 basis using the GSAT-15 satellite. Initially, each channel was providing 4 hours fresh content daily which was repeated 5 times a day to make the channel 24x7. Now this slot of 4 hours is being increased to 6 hours. The channels are uplinked from Bhaskaracharya Institute for Space Applications and Geo-Informatics (BISAG), Gandhinagar. The contents are provided by NPTEL, IITs, UGC, CEC, IGNOU, NCERT and NIOS. The INFLIBNET Centre maintains the web portal. These channels are freely available on Doordarshan's Free DTH TV networks, Zee's Dish networks and Jio TV networks. These SWYAMA PRABHA channels telecast curriculum-based contents of the subjects taught in school from class IX to under-graduate and post-graduate level. The idea is to help students access best video resources and allow them to pick their own time for learning.

Along with SWAYAM PRABHA, SWAYAM was also launched on 9th July 2017 by the Hon'ble President of India. SWAYAM, an acronym for Study Webs of Active –Learning for Young Aspiring Minds, is a digital platform which hosts several courses offered by the best teachers of universities/colleges/ schools free of cost to the students living in any part of the country. It's a massive platform because students in very large number can join any course.

There are no seat-restrictions. It's open to all free of cost and it is available online. SWAYAM (swayam.gov.in) has been developed by the Ministry of Human Resource Development (MHRD) and All India Council for Technical Education (AICTE) with the help of Microsoft. The courses hosted on SWAYAM are in 4 quadrants – 1) video lectures, 2) textual materials in digital format, 3) self-assessment tests and 4) online discussion forum for clearing doubts. In order to ensure that the best quality contents are produced and delivered, nine National Coordinators have been appointed. They are AICTE for self-paced and international courses, NPTEL for engineering, UGC for non technical post-graduation education, CEC for under-graduate education, NCERT & NIOS for school education, IGNOU for out of the school students, IIMB for management studies and NITTTR for Teacher Training programme. University Grants Commission (UGC) has made provisions for transferring credits for the courses done on SWAYAM. Such courses are also known as MOOCs (Massive Open Online Courses).

MOOCs is an excellent example of use of internet in education. Through MOOCs, we tend to achieve all three concerns of our education, viz., access, quality and equity. There are several platforms available for students to choose. MOOCs is a relatively recent development and can be used in variety of ways from offering courses offered in colleges and universities to courses designed for mid-career professionals to in-house programs for skill training and so on.

ShaGun portal (http://seshagun.nic.in/) was launched by the MHRD, Government of India (GoI) last year to monitor the progress of SSA scheme on the regular basis and also to make this portal a repository of best practices, innovations, success stories and resources available in the States/Union territories (UTs). ShaGun stands for *Shala* meaning schools and *Gunvatta* implying quality. Shaala siddhi (http://www.shaalasiddhi.nuepa.org) launched by National Institute of Educational Planning and Administration (NIEPA), New Delhi aims to improve the school functioning by evaluating schools holistically on 7 key domains such as i) enabling resource of schools, ii) teaching-learning and assessment, iii) learners progress attainment, iv) teacher performance, v) leadership and management, vi) inclusion health and safety and vii) productive community participation. Similarly, Kendriya Vidyalaya's Shaala Darpan is an e-government platform for all KV schools in the country to improve quality of learning, efficiency of school administration, governance of schools and service delivery to key stakeholders. DIKSHA (https://diksha.gov.in/), a joint initiative of MHRD and National Council for Teacher Education (NCTE) was launched by the Hon'ble Vice President this year to make one stop resource for all requirements of a teacher.

In recent times, government has launched plethora of schemes, programs to integrate technology in education. Convergence of technology, resources and services remain a challenge. Internet with computers and social/new media has lot to offer. We need to find our own solutions. In a digitally divided society, our over-dependence on technology for all kinds of solutions will not take us far.

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Jharakhand to become ODF by 15th November, 2018

Union Minister for Drinking Water and Sanitation Uma Bharati said that with the present rate of sanitation coverage in the state, Jharkhand will become open defecation free state on it's upcoming foundation day - 15th November. She was speaking at the event of Ganga Gram, which is a concept to transform banks on the village of River Ganga into ideal villages with emphasis on ODF, Solid and Liquid Waste Management, Water Conservation, Ground Water Recharge, modern crematorium, tree plantation, organic and medicinal plant agriculture being its main components. After making all 4465 Ganga Bank villages ODF, the Ministry of Drinking Water and Sanitation is working in this direction. In this regard, Uma Bharati stressed upon public participation as the key to make Ganga Bank villages ideal Ganga Grams. Secretary, Ministry of Drinking Water and Sanitation, Parameswaran Iyer highlighted the societal and financial gains of Swachh Bharat Mission (SBM). It is noteworthy that, in past four years, sanitation coverage in rural India has gone up from a lowly 39 per cent to over 95 per cent. According to reports from organisations such as UNICEF and WHO, an average family in an ODF village saves Rs. 50,000 annually on it's medical expenditure, and also that with such a growth, SBM would save about 3 lakh lives by October 2019.

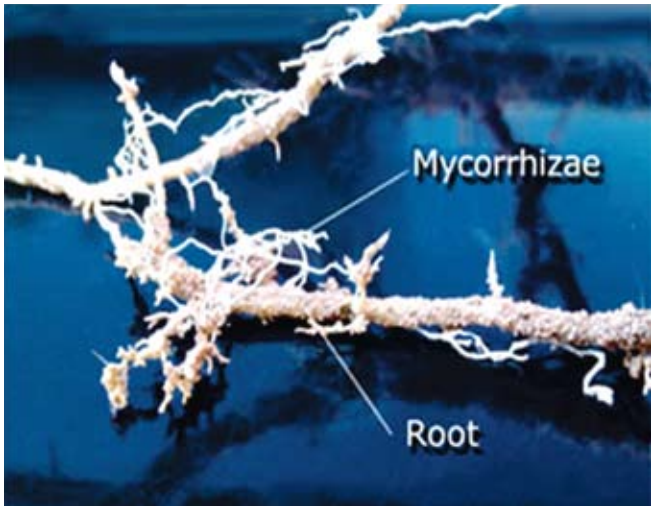
BIO FERTILIZERS FOR SUSTAINABLE FOOD PRODUCTION

Dr Rakesh Singh Sengar & Devendra Kumar

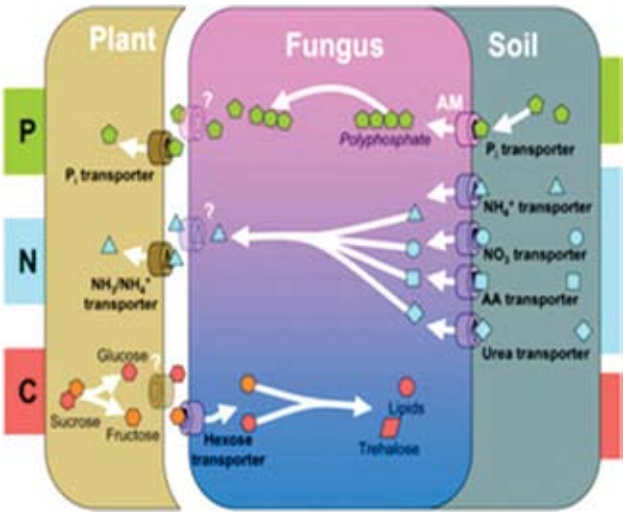
Mycorrhiza as biofertilizer form a network of filaments that associated with plant roots, increases the absorption of nutrients, particularly phosphorus and thus enhance the growth of crop plants and trees. Therefore, it is important in crop production and receiving considerable attention in agriculture. Currently, VAM (Vesicular Arbuscular Mycorrhiza) as biofertilizer is utilized in fumigated soils, greenhouse crops, and in the reclamation of disturbed sites. Ectomycorrhizae are employed in the establishment of trees in nurseries and in the production of containerized seedlings. They improve soil quality by binding particles together in addition to the provision of nutrients.

It has been observed that up to 90% of applied P-fertilizer(Phosphorus fertilizer) is rendered unavailable for crop uptake due to fixation. For P-fixation, mycorrhizal inoculation of plants is one of the alternatives. Fungi, which form symbiotic association with roots of plants are referred as mycorrhizal fungi and the association itself is referred to as "mycorrhizae". "Mycorrhiza" is made up of two words- mycor (fungus) and rhiza- (root) and literally means root fungus. These soil microorganisms i.e. the fungus are thought to be as old as our mother land and distributed all over the earth. Mycorrhiza form a network of filaments that associated with plant roots, increases the absorption of nutrients, particularly phosphorus and thus enhance the growth of crop plants and trees. Therefore, it is important in crop production and receiving considerable attention in agriculture.

Currently, VAM (Vesicular Arbuscular Mycorrhiza) as biofertilizer are utilized in fumigated soils, greenhouse crops, and in the reclamation of disturbed sites. Ectomycorrhizae are employed in the establishment of trees in nurseries and in the production of containerized seedlings. They improve soil quality by binding particles together in addition to the provision of nutrients. Various functions of the mycorrhiza (VAM), except Chenopodium, Brassica etc. as these are not infected by this fungus, are as follow;

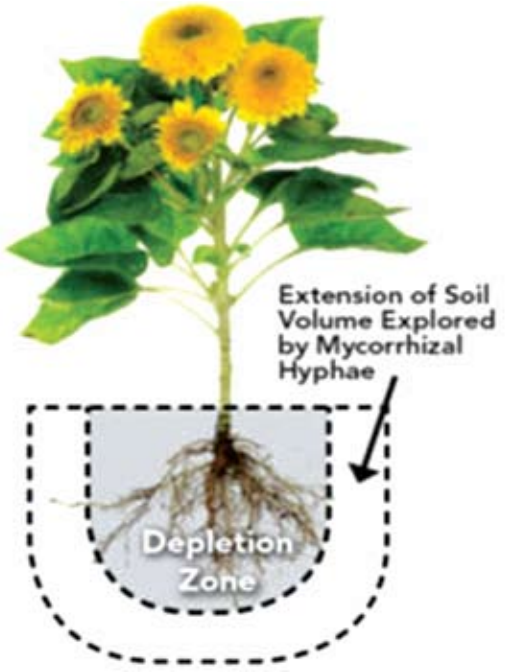


a) The main function of the mycorrhiza is to dissolve the fixed phosphate available as insoluble phosphate in the rhizosphere zone i.e. the zone in the soil surrounding the roots



and make it available to the plants through the hypha roots which are tube like structure that these fungi leave into the rhizosphere zone through which the dissolved phosphate reaches the roots.

b) Mycorrhiza also helps in the dissolution of trace elements which are in the form of insoluble compounds due to high alkalinity and make them available to the plants. The continuous use of urea over the years since mid sixties when green revolution started has caused the soil to become more alkaline and the trace elements already available in the soil



acquired the form of insoluble hydroxides/ other amines.

c) These fungi synthesize certain chemicals like HCN (Hydrogen Cyanide) etc. and release them in the rhizosphere zone, which protect the feeder roots of plants from the attack of various pathogens in the rhizosphere zone.

d) The mycorrhiza also helps during the nitrogen fixation because the phosphate requirement in the nitrogen fixation and water transport is fulfilled through mycorrhizal activity hence mycorrhiza can be used with Rhizobium.

Arbuscular Mycorrhizae (AM):

These are the most common mycorrhizae, first to evolve and members of the Glomeromycota, they are obligate biotrophs and associated with roots of about 80% of plant species, including many crop plants. The AM association is endotrophic, and has previously been referred to as vesicular-arbuscular mycorrhiza (VAM). AM persists as large spores of up to 400um diameter in soil and infect roots from germinating spores by forming an aspersorium like structure on the root surface. From this, the hyphae grow between the root cortical cells and penetrate individual root cells to form arbuscles, which are extremely finely branched tree like structures that occupy most of the cell volume. Arbuscles have a lifespan of 14 days. However the supply of mineral nutrient to the host is known to occur before the arbuscles are digested. The commercial inoculants are made from infected root fragments, hyphal fragments and spores, mainly of fungi in *Glomus* genus.

Ericoid endomycorrhizae:

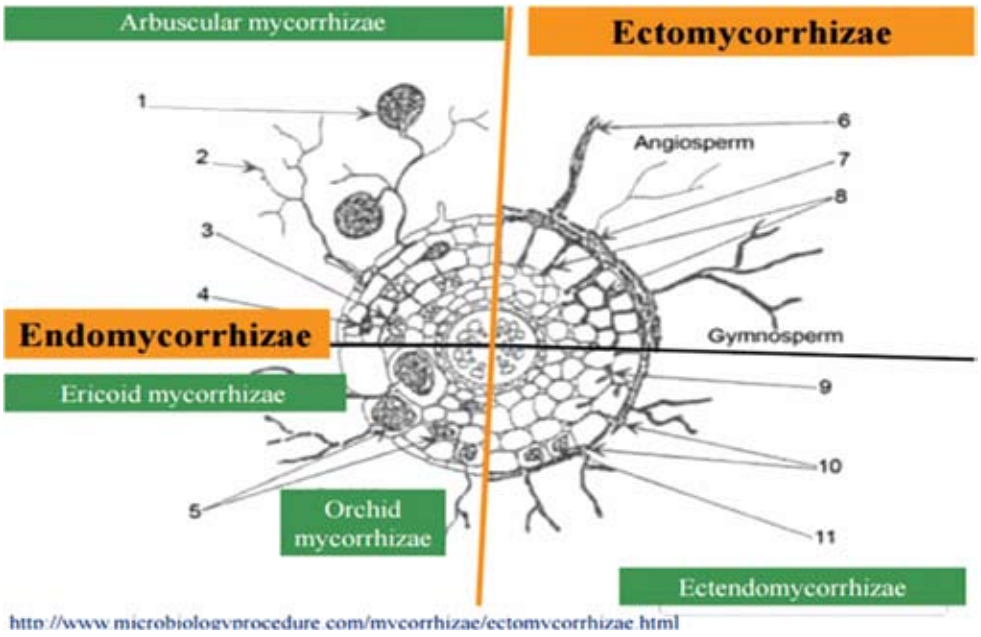
Fungi are members of the Ascomycota (*eg*. *Hymenoscyphus ericae*). The plant's rootlets are covered with a sparse network of hyphae; the fungus digests polypeptides saprotrophically (extracellular digestion) and passes absorbed nitrogen to the plant host; in extremely harsh conditions the mycorrhiza may even provide the host with carbon sources (by metabolising polysaccharides and proteins for their carbon content). Two specialized subgroups may be separated out of the ericoid endomycorrhizal group- (i) Arbutoid endomycorrhizas, (ii) Monotropoid endomycorrhizas.

Orchidaceous endomycorrhizae:

Similar to ericoid mycorrhizae but their carbon nutrition is more dedicated to supporting the host plant as the young orchid. All orchids are achlorophyllous in the early seedling stages. A characteristic fungus example is the basidiomycete genus *Rhizoctonia* (a complex genus which can be divided into several new genera).

Ectomycorrhizae:

Ectomycorrhizal fungi are mainly Basidiomycota and include common woodland mushrooms, such as *Amanita* spp. most advanced symbiotic association between higher plants and fungi involving about 3% of seed plants including the majority of forest trees. In this association, the plant root system is completely surrounded



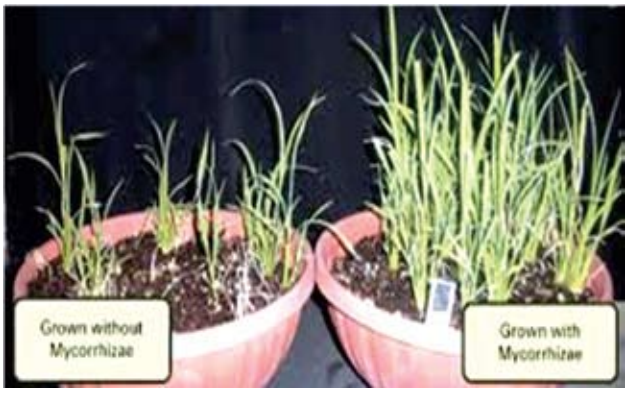
by a sheath of fungal tissue. The hyphae penetrate Hartignet.

Ectendomycorrhizae:

Ectendomycorrhizas have the same characteristics as ectomycorrhizas but show extensive intracellular penetration of the fungal hyphae into living cells of the host root.

Inoculation Methods:

VAM inoculum is now commercially available in India. VAM is now available in 1 kg pack costing Rs. 100 under the trade name "Ecorrhiza" and "Josh" respectively. For one acre of the land, 4-5 kg of VAM inoculums is sufficient which can be mixed with 200 kg of powdered cow dung manure/ FYM/ soil and mixed in the fields uniformly while preparing the fields (Anon, 2006). The field can be ploughed two-three times so that it gets distributed in the soil. Inoculums may differ depending upon the number of plants per acre. When the number of plants per acre are more than 40,000, 5-10 kg of inoculum is required as the requirement of the plants increases with the increase of plants.

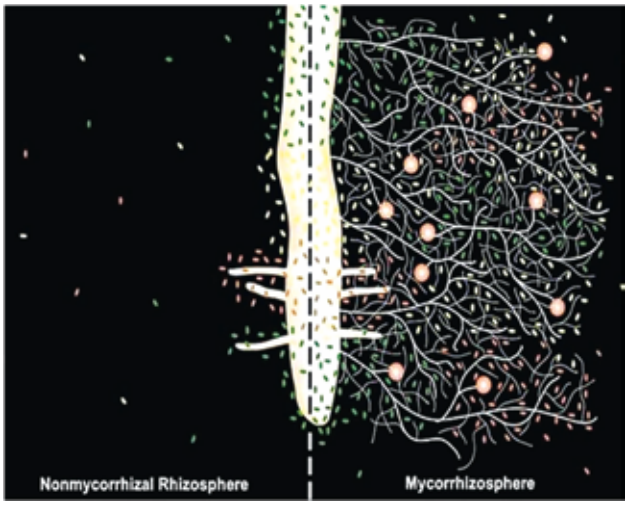


Inoculation of crops directly sown in the field:

Seed coating with AM inoculums: Coating with mycorrhizae inoculum is the easiest method of inoculating plants with AM fungi, if it provides consistently good infection. Seeds are coated with an adhesive e.g. methyl cellulose, to which inoculum is expected to stick and subsequently infect the emerging radicles.

Mycorrhizae pelletes: This method is technically more feasible to incorporate seeds in to inoculums to form multiseeded pellets rather than coating seeds with AM inoculums. These pellets about 1cm in diameter consists of soil inoculum from pot cultures, stabilized with clay or peat inoculums.

Inoculums in furrows: Placing inoculums under or beside seed sown in a furrow is probably an effective method of inoculating field sown crops.



Pre-croping: Population of AM propogules can be raised *in situ* by growing strongly mycorrhizal host plants and leaving the infected roots and associated spores in the soil to infect the next crop.

Fluid drilling: Incorporations of seeds and inoculums in a uniform suspension are another means of placing seeds and inoculum in proximity.

Inoculation in transplanted crops:

Seedlings may be dipped into the water suspension of the inoculum containing some jaggery or molasses before transplantation. Alternatively, the seed beds may be inoculated with VAM while raising the nursery.

This method includes putting 2 g of the inoculum in the micropits to a depth of 3-4" below the soil level while transferring the seedlings in the fields. Even if the seedlings have been stabilized after the transplantation, the inoculums with VAM can still be carried out by making 5" deep holes with a hollow pipe (1-2" diameter) 1-2" away from stems of the plants and putting 2 g of VAM inoculum in these holes and then filling the holes with soil.

Seedlings are raised in sterilized or unsterilized soil supplied with selected AM fungi in small nursery beds and planted out when mycorrhizae colonization is well established. This method has been successfully used to produce in agronomically important crops like citrus, mango, asters, and marigold and forest tree species like *Leucaina, Casuarina equisetifolia. Tamarindus indica,* and *Acacia nilotica.*

Conclusion:

Mycorrhiza, a potential biofertilizer is considered as a boon for agriculture because it provides phosphate, other trace elements to the plants by forming a symbiotic association with plants. By the use of nitrogen fixing biofertilizers with mycorrhiza, PSB and organic manure, it will increase the C:N (Carbon to Nitrogen ratio) and ultimately, leading to increased production.

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Women of India Organic Festival 2018

The 5th edition of the 10-day 'Women of India National Organic Festival 2018' was inaugurated on 26th October 2018, at IGNCA, Janpath Road by the Union Minister of Women and Child Development, Smt. Maneka Sanjay Gandhi, Over the 10 days, women farmers and entrepreneurs from across the country, participated with vast variety of organic products ranging from food and fabrics to wellness and personal care participated in this festival, is an annual affair and serves as a platform to celebrate and promote women farmers and entrepreneurs from different corners of India.

This year, the total sales by the women farmers and entrepreneurs who came from 26 States, were a record of over Rs. 2.75 crore, up from Rs. 1.84 crore in last year's edition that was organised at Dilli Haat, INA, New Delhi. The festival is had footfall of nearly 12 lakh. The success of the Organic Festival has added to the joy of the women farmers from diverse as well as far off corners of the country, such as Majuli, Kangra, Leh, Palakkad, Chikkmaglur, Yavatmal, Dimapur and Almora, among others. Participants had the opportunity to travel and stay in Delhi free of cost for the entire duration of the Festival while enjoying the experience of selling their wholesome goods to Delhiites, who thronged the lawns of IGNCA, not only on weekends, but also on weekdays. This year saw the grand debut of the Food Court and Vegan Food, which were very well received by all visitors.

The participants of Women of India National Organic Festival 2018 also had the opportunity to enroll themselves in Mahila-E-Haat, which is an online marketing portal set up by the Ministry of Women & Child Development, to meet the aspirations and needs of women entrepreneurs.

RENEWABLE ENERGY ADOPTION FOR RURAL AREAS

Dr M. V. Ravibabu and Dr Sainu Franco

With increasing pollution of the biosphere due to the burning of fossil fuels and cutting of forests, development of renewable energy has become a major societal challenge. Renewable energy, with its renewability and non-polluting property, promises to grow to be an effective and practical choice. India has substantial renewable energy sources, including a large land mass that receives among the highest solar irradiation in the world, a long coastline and high wind velocities that provide many opportunities for both land-based and offshore wind farms, significant annual production of biomass, and numerous rivers and waterways that have potential for hydropower.

A village is deemed "electrified", if at least 10% of the households and public places such as schools and health centres are connected and receive electricity from the grid, through the transformer established in the village. This would still leave 90 % of people living in these villages "un-electrified". Total electrification can be a reality only when all households and hamlets are connected. Homes without electricity are spread across major states such as Madhya Pradesh, Rajasthan, Bihar, Assam, Odisha, and Jharkhand each having nearly 6 million unconnected households. According to Debajit Palit, Associate Director at The Energy and Resources Institute, 14.6 million households in the giant north Indian state of Uttar Pradesh lack access to electricity.

The government did embark on an ambitious $2.5 billion program named "Saubhagya", in order to provide power connections to every household by the end of March 2019. While the process of electrification involves 3 steps, the first being the extension of infrastructure to the village, followed by connecting the household, the last and most critical and challenging part would be to ensure the supply of reliable and affordable energy that is sustainable.

Decentralized renewable energy in the form of mini-grids and rooftop solar are a crucial part of the solution where the grid can't reach or serve in a reliable manner. It is here that distributed renewables have a crucial role to play, for energy to be universally accessible. People in some villages have started using solar energy for running their businesses even before the government power lines were installed. Many rely on off-grid solutions, despite being connected to the grid.

It is a known fact that India relies on coal, to meet 60% of its electricity demands. With stagnation in the

production of coal, it would be an uphill task for the government to provide uninterrupted power to its citizens. Thermal power also has potentially harmful effects on the environment. Burning biomass for cooking and other purposes are rampant in villages, adding to the pollution while cutting down precious forest resources that act as a valuable carbon sink as well.

With India's energy distribution companies suffering huge losses and on the brink of collapse, increasing the share of renewable energy in the energy mix should be high on the policy agenda. However, despite the numerous advantages, it has been observed that the general public has been slow in adopting this form of energy. The dissemination of renewable forms of energy has been greatly curtailed due to lack of institutional capacity, among others. A study by Tafesse et al, 2018, empirically tested the impact of cooperatives on Renewable Energy adoption in rural parts of Ethiopia and have come up with some interesting findings. Members of the cooperatives could be more easily influenced and convinced to invest in Renewable Energy as compared to non-members.

Energy is a critical factor and foundation for economic growth and social progress. With increasing pollution of the biosphere due to the burning of fossil fuels and cutting of forests, development of renewable energy has become a major societal challenge. Renewable energy, with its renewability and non-polluting property, promises to grow to be an effective and practical choice guaranteeing the future development of the world . Renewable energy commonly refers to those energies that do not pollute the environment and could be recycled naturally. International experts have categorized renewable energy as traditional and new. The former referring to giant hydropower and biomass burnt directly, while the latter refers to small hydropower, geothermal energy, wind energy, biomass energy, solar energy, ocean energy, etc.

While hydroelectricity refers to potential and kinetic energy of water being converted into electricity in hydroelectric plants, Geothermal energy is available as heat emitted from within the earth's crust, usually in the form of hot water or steam. It is used either for electricity generation, heat production for sale to third parties or directly as heat in its primary form. In solar plants, the solar radiation is exploited for electricity generation and hot water production. Solar photovoltaic is solar radiation exploited for generation of electricity using photovoltaic cells. In Tide/Wave/Ocean, the mechanical energy derived from tidal movement, wave motion or ocean current are exploited for electricity generation. In wind, kinetic energy of wind is exploited for electricity generation by the use of wind turbines. In biogas plants, the gases composed principally of methane and carbon dioxide that are produced by anaerobic fermentation of biomass, or by thermal processes which includes landfill gas, sewage sludge gas, other biogases from anaerobic digestion and biogases from thermal processes are utilized (IEA, 2014).

India has substantial renewable energy sources, including a large land mass that receives among the highest solar irradiation in the world, a long coastline and high wind velocities that provide many opportunities for both land-based and offshore wind farms, significant annual production of biomass, and numerous rivers and waterways that have potential for hydropower (NREL, 2010). The Ministry of New and Renewable Energy (MNRE) is promoting multifaceted biomass gasifier based power plants for producing electricity using locally available biomass resources such as wood chips, rice husk, arhar stalks, cotton stalks and other agro-residues in rural areas. Though these different forms of energy fall under the umbrella of renewable energy sources, some of these are location specific and require huge investments initially apart from highly technical man-power and hence unsuitable for rural electrification purposes, especially in India where villages are scattered geographically and sometimes located in difficult terrain.

Increasing the share of renewables in the energy mix is high on the policy agenda in countries around the world. Several governments have set highly ambitious targets and have started to implement support schemes aimed at facilitating implementation. The degree of success of these policies varies between countries (Wüstenhagen et al., 2007).

The issue of adoption and factors that determine adoption rate, of renewable energy, needs to be understood and addressed if it is to be implemented successfully (Wüstenhagen et al., 2007; Hrayshat, 2007). The investment in this form of energy is considered risky, requiring too much time before the capital invested is recovered and starts yielding returns . Recent research indicates that successfully implemented renewable energy projects are usually managed by co-op ventures rather than profit motive driven corporations (Subbarao and Lloyd, 2011). Co-ops are autonomous associations of people united voluntarily, in order to satisfy their mutual economic, social, and cultural needs and aspirations through jointly owned and consensually controlled enterprise (ICA, 1995). The system of voluntary and open membership and the considerable co-determination rights for members makes co-ops compatible with the societal expectations of multi-dimensional sustainability goals with regard to projects of renewable energy (Yildiz, 2014).

Viardot (2013) deliberates upon a number of possible constraints to RE adoption and tries to address how RE co-ops can minimize them. These constraints include: (i) unfamiliarity with the technology, (ii) lack of awareness of the environmental benefits, (iii) opinion that the technology is unreliable, (iv) belief that the technology can have harmful side effects, (v) unsuitable location for the installation, (vi) inability to access sufficient credit, (vii) invested capital needed elsewhere, and (viii) fear of the administrative work involved in RE systems. It

was found that communication was an important initiative taken by RE co-ops to decrease the barriers to RE adoption. In rural India, the solution for rapid economic development can come in the form of rural cooperatives. Rural India requires institutions that are helpful in creating confidence, organizing people and utilizing their resources effectively. From this point of view, rural cooperatives have a vital role to play. Co-ops can make bulk purchases of RE equipment to get volume discounts, which can be passed onto its members, lowering the price of RE.

What's more, co-ops develop projects on local sites, responding to the constraint of location and availability of RE. Local projects contribute to increasing the social backing of RE. Furthermore, RE co-ops are headed by a democratically elected management representing the interests of the community they serve. This alleviates another barrier related to the bad image of an RE technology. Co-ops effectively contribute to the uptake of RE with community-based social marketing initiatives that are creating the promotional factors required for a secure investment environment. A recent study from Bihar suggests that a critical determinant of electricity access in rural India is proximity to the Central power grid. This essentially suggests that remote villages in rural India would be deprived of access to power. Hence, it is imperative that rural India develops and adopts self-sustaining community-managed local generation, storage and grid-connected electricity models (popularly termed microgrids).

The Government of India should consider setting up of the solar plants through a large number of Renewable Energy Cooperatives rather than through setting up Mega Solar parks. It is better to set up 500 numbers of 1 MW plant in each village rather than setting up a single 500 MW in one location. Providing grid electricity for the rural population is not economical due to the scattered ways of settlement and, low and seasonal income of the rural households. Off-grid rural electrification with RE is the best alternative to provide electricity for the rural population (Kotu, 2012). RE is the inevitable choice for sustainable economic growth and for the harmonious co-existence of humans and the environment as well as for sustainable development.

Grossbardorf, a village in Germany runs a successful microgrid rural cooperative model that generates four times the electricity needed to power individual businesses and homes of the community. Excess power is fed back to the main electricity grid through a feed-in tariff system, and the revenue generated is shared equally among the various stakeholders. While Germany is well-known for its proactive collective renewable energy initiatives, a good number of success stories are emerging from different parts of India. A biomass-based rural cooperative in Tumkur district of Karnataka owes its success to institutional aspects like well-defined property rights in ownership, institutionalised markets and decentralised environmental governance. The biomass is derived through tree-based farming, which provides employment to 30 households.

One of the reasons why the cooperative model of enterprise has been effective is that it responds to the increasing demand for democratization of energy. In cooperatives, decisions are taken democratically, at the community level, and often by end users, thus empowering people and promoting equal participation. The growth of energy cooperatives, particularly in the renewable energy sector, suggests that cooperatives are increasingly being chosen by people around the world to respond to their needs. However, this growth is also attributable to increasing public interest in community-owned and locally based energy solutions, new energy regulations and support measures for renewable energy, and raised awareness on green issues and climate change.

However, renewable energy-based rural cooperative models across India would require high levels of initial seed capital. Banks, governments and international agencies such as the United Nations may not help in achieving the scale of financing required. So, it is imperative that private players such as big industrial houses and high net-worth philanthropic individuals take the lead in establishing rural energy cooperatives. The need of the hour is a private-cooperative partnership.

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Digital Technology in Financial Inclusion

Financial Inclusion is the way the Governments strive to take the common man along by bringing them into the formal channel of economy thereby ensuring that even the person standing in the last is not left out from the benefits of the economic growth and is added in the mainstream economy thereby encouraging the poor persons to save, safely invest in various financial products and to borrow from the formal channel when they need to borrow.

Scope of the financial inclusion is not limited to only banking services but it extends to other financial services as well like insurance, equity products & pension products etc. Thus, financial inclusion is not just about opening a simple bank account with a branch in an unbanked area.

The present government has made itself committed, since beginning of its term, to give special emphasis on the financial inclusion of every person of the country. One of the most crucial of the several steps taken by this government is JAM- Jan Dhan, Aadhar & Mobile.

With a view to increase the penetration of banking services and to ensure that all households have at least one bank account, a National Mission on Financial Inclusion named as Pradhan Mantri Jan Dhan Yojana was announced by Prime Minister Sh. Narendra Modi in his independence speech on 15th August, 2014 and the scheme was formally launched on 28th August, 2014. PMJDY has been designed to ensure accelerated access to various financial services like basic savings bank accounts, affordable, need-based credit, remittances facilities, and insurance and pension for excluded sections. Such deep penetration at affordable cost can only be possible with effective use of technology. Hence, the banking ecosystem operating on core banking mode, and ability of NPCI to scale-up issue of debit cards has enabled effective implementation of PMJDY. As a result, the number of new savings accounts opened by the banking system has been phenomenal under the scheme. The use of technology, by way of every Bank A/c to be on-line with RuPay Card & Mobile Banking Facility, use of e-KYC to ease the account opening process, use of Aadhaar Enabled Payment System (AEPS) for interoperability, support for setting up FLCs, support for demonstrating banking technology (Mobile Van fitted with ATM), on-line Monitoring through system generated MIS and facility of Call Centre & Toll free number has resulted in astounding success of the scheme.

To expand the network of ATMs, the RBI has allowed non-bank entities to start ATMs (called 'White Label ATMs'). The RuPay Cards have significantly increased its market share in the country so far. The card has been provided to the account holders of PMJDY .

Financial Literacy Centers were started by commercial banks at the request of RBI to give awareness and education to the public to access financial products. Here, RBI's policy is that financial inclusion should go along with financial literacy. The launch of direct benefit transfers through the support of Aadhaar and Bank Account is one of the biggest developments that activated and retained people in the newly opened account.

As a part of its financial inclusion plan, the RBI started the Business Correspondent model in 2006. Business Correspondents (BCs) are representatives appointed by banks to act as their agents, who provide

banking services in remote locations, where the bank may not have a presence. The two major technological components involved are the hand-held offline device through which financial services are offered to the customers and the smart card (32k/64k memory chip) provided to each customer for recording of transactions. Along with these, the BC uses an Account Opening Form (AOF) and a laptop for feeding customer data, a digital/web camera for capturing customer's photograph and a biometric device for recording his fingerprints.

The Digital India initiative, coupled with a payment infrastructure, is laying the cornerstone for a digital economy, keeping in mind the increasing willingness of people to use the internet and the rising data traffic in the country, an investment of $18.4 billion has been made to provide last mile internet connectivity, better access to government services, and development of IT skills, Provision of broadband internet access to 250,000 village-clusters by 2019 at a cost of about $5.9 billion.

Rupay Kisan Cards have been providing impetus to cashless transactions among the farming community. NABARD has extended support to Cooperative banks and RRBs in procuring EMV chip-based Rupay Kisan Cards.

Direct Benefits Transfer scheme was initiated to facilitate disbursements of government entitlements such as those under the social security pension scheme, handicapped old age pension scheme, etc., of any central or state government bodies, using Aadhaar and authentication thereof, as supported by UIDAI.

Payments banks are a new model of banks conceptualised by RBI. The main objective of payments bank is to widen the spread of payment and financial services to small business, low-income households, migrant labour workforce in secured technology-driven environment in remote areas of the country.

Today more than 70% of our population owns mobile phone, hence, leveraging it's penetration to rural areas, with it's advantages over traditional banking methods because of breaking down geographical constraints alongwith immediacy, security and efficiency, it offers an innovative low-cost channel to expand the reach of banking and payment services especially to the large section of rural mobile subscribers.

To promote digital transactions for personal consumption expenditure, two schemes viz. Lucky Grahak Yojana and Digi Vyapara Yojana were funded through Financial Inclusion Fund for consumers and merchants respectively. National Payments Corporation of India (NPCI) determines the winners for cash rewards by choosing them through an electronic draw of lots from amongst the digital transaction IDs generated from 8 Nov. 2016, during the course of such transactions. Apart from this, the Financial Literacy Awareness Programmes were recast as d-Flaps, with an objective of transition from a cash-based economy to less-cash one. The digital modes of transactions like mobile apps, USSD-based transaction are also explained/ demonstrated in dFLAPs held across the country.

Shri Ravi Shankar Prasad, Union Minister for Electronics & Information Technology and law & Justice sums up the crucial role of digital technology in financial inclusion "Digital inclusion is the foundation of financial inclusion. We have certain fundamental approach for commitment as far as digital platform is concerned. The first and foremost is, we want to become the leaders in the field of digital revolution in the world. Second important attribute of our initiative is, we simply don't want to digitize India, but we want to create a technology that is transformative, which will empower India, and also empowers Indians."

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