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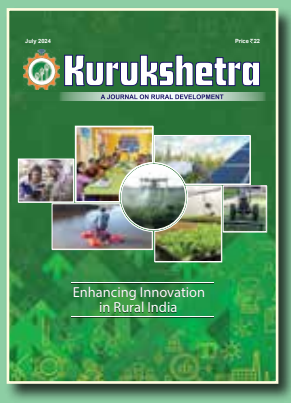
Kurukshetra

A JOURNAL ON RURAL DEVELOPMENT

Enhancing Innovation in Rural India



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EDITORIAL OFFICE
Room No. 653,
Publications Division,
Soochna Bhawan, C.G.O. Complex,
Lodhi Road, New Delhi-110003
Phone : 011-24362859
Email : kurukshetrajournal@gmail.com

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Journals Unit
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Soochna Bhawan, C.G.O. Complex,
Lodhi Road, New Delhi-110 003
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Editorial

Innovation is central to the economic growth and development of any country. In the context of rural India, innovative approach provides new ways to solve the problems of rural people and create new opportunities for entrepreneurship development.

Innovations in the form of Agri-Technology, Renewable Energy Initiatives, Digital Empowerment, Rural Entrepreneurship, Water Management Solutions, Education and Skill Development, Community-Based Tourism and Healthcare Access can alleviate the drudgery out of the lives of rural people and fulfill their need for a low-cost local solution to a widespread rural problem.

This issue of Kurukshetra includes articles deftly dealing with the innovations for rural India and how their adoption can contribute in economic growth and development of the rural population and the country as well.

The Article *'Jugaad Innovation- Transforming Rural India'* has adequately discussed about these frugal innovations in rural India which have really transformed the rural sectors specially the agriculture sector. Whereas the article *'Adoption of digital technology in rural areas of India'* focuses on the role of digital India in enhancing Innovation in rural India thus making the most of technological progress and strengthening a number of factors including technological and civil infrastructure, quality education and skills training etc.

Innovative ideas in development have notably reduced the gap in equitable distribution of development potential between urban and rural populations. The article *'Rural India: Innovation for Inclusiveness'* ponders over the impact of innovation in nurturing the Indian rural sector.

Dairy farms have undergone a radical change because of innovations in technology and automation in India. The article *'Rebooting Operation Flood through Automation'* aptly discusses about the innovation and use of technology bringing tremendous changes in the Dairy sector.

The Article '*Innovations: Driver of Rural Growth and Development'* explores some of the groundbreaking innovations in rural India which have unprecedented impact on agriculture sector leading to the development and growth of economy and livelihood of the rural population.

Deviating slightly from the main theme, an article *'Making Lakhpati Didis-Multiple livelihoods show the way'* focuses on successful implementation of the Deendayal Antyodaya Yojana-National Rural Livelihood Mission (DAY-NRLM) by creating Self Help Groups (SHG) and Integrated Farming Clusters for rural women.

There are challenges to rural development including inadequate infrastructure, limited access to markets, environmental degradation, lack of education and healthcare facilities, and insufficient financial resources. Yet we can empower rural population, unlock their potential, and build more inclusive and sustainable societies by adopting technological innovation and investing in digital solutions. ❑

Making Lakhpati Didis
Multiple Livelihoods Show the Way

As the mobilisation of poor households into SHGs and financial inclusion has reached saturation levels, the focus has shifted now to creating sustainable livelihoods for the members. Under the livelihood interventions, the stress is on creation of different livelihood models across the farm and non-farm sectors and combinations of them for enhancing the household income in a manner that each household earns at least one lakh rupees in year, i.e., it becomes Lakhpati.

***Charanjit Singh**
****Raman Wadhwa**

Deendayal Antyodaya Yojana – National Rural Livelihoods Mission (DAY-NRLM) is one of the world's largest poverty eradication programmes across the world, being run under the aegis of the Ministry of Rural Development, Government of India. The Mission through its inclusion strategy has mobilised more than 10 crore households into 91 lakh Self-Help Groups (SHGs) and their higher community institutions. These households through the above institutions are being provided capitalisation support to enable them inter-loaning and to connect them to formal financial institutions.

As the mobilisation of poor households into SHGs and financial inclusion has reached saturation levels, the focus has shifted now to creating sustainable livelihoods for the members. Under the livelihood interventions, the stress is on creation of different livelihood models

**The author is Additional Secretary (Rural Livelihoods), MoRD, GoI*
***The author is Deputy Director (Admin), NRLPS, GoI*

across the farm and non-farm sectors and combinations of them for enhancing the household income in a manner that each household earns at least one lakh rupees in year, i.e., it becomes Lakhpati. In this initiative of Lakhpati Didis, the sub-scheme of Integrated Farming Clusters (IFCs) is playing a critical role.

An Integrated Farming Cluster (IFC) comprises two to three (this may change depending on the State) adjoining intervention villages covering about 250-300 households. These households are supported with improvement in two to three livelihood options (farm and non-farm) with strong backward and forward linkages. The IFC strategy lays focus on landless, leased-in-land farmers, rain-fed farmers and introduces a more comprehensive approach to provide an end-to-end solution to the livelihoods of the poorest for income enhancement. The approach ensures each targeted household has a basket of income sources to provide regular income stream throughout the year. The process comprises production and processing/value addition within the cluster through asset creation, skilling the producers to enhance productivity, and importantly, ensuring access to credit at affordable rates. The access to market and access to improved technologies are a few critical challenges that are being addressed in this approach.

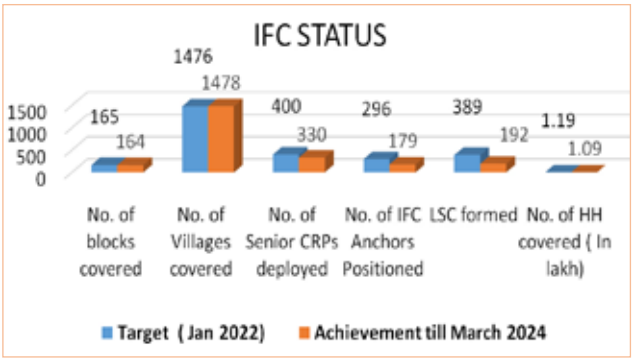
Strategy

The IFC focuses in those areas of Mission where the social mobilisation and financial inclusion processes have reached saturation and initial livelihood initiatives related to production and productivity are well grounded. The approach is to ensure that each targeted household has a basket of regular income sources throughout the year. It aims to create output consistency and high profitability to protect farmers from the whims of the monsoon and fluctuation in market prices.

An end-to-end strategy is the value chain approach. The objective is to identify and address the critical constraints in a coordinated way, thereby unlocking the potential of the value chain. The process comprises of: (i) Asset Creation for enhancing production and processing/value addition, (ii) honing skills of producers to augment their productivity, (iii) ensuring access to credit at affordable rates and (iv) facilitating access to market and improved technologies. In addition, wherever, a sizable population exists, focus is also placed on small ruminant productivity enhancement, horticultural diversification, and climate-resilient agriculture.

On the front end (value addition and market linkage), the cluster collectivises and aggregates individual produce at the village and/or cluster level through small Producers' Collectives like Producers Groups (PGs). These PGs are informal institution that aggregate the individual produce, thus reducing the transaction cost of primary value addition and market linkages. In more extensive geography, these small producers' collectives may be federated into Producers Enterprises for larger aggregation, secondary value addition/processing, packaging, labelling, and market linkage/marketing directly and/or through partnership.

To create enabling environment a tripartite MoU was signed between Indian Council of Agricultural Research (ICAR), RCRC (Conglomerate of Civil Society Organizations), and DAY-NRLM in 2021 whereas the ICAR is the technical partner, and RCRC through its multiple partners facilitates implementation. The program was launched in December 2021 at Ranchi, Jharkhand. In the 1st phase, 400 such IFCs were allocated to 13 States supported under World Bank funded National Rural Economic Transformation Project (NRETP) with a total



duration of 3 years. The details of their progress in terms of physical achievement are as under:

Mahila Kisans (Women farmers)- The Torch Bearers

In IFC, the Mahila Kisans are central actor in every intervention, both as farmer and the entrepreneur. The project design and implementation have enough provisions for the active participation of women. Still, this issue is complex and present in every sphere. Further, it is an outcome of how society tends to view and operate the social construct. It needs greater awareness and active engagement plan at the household level and outside, and all the stakeholders' mindset change in favour of women participation.

Objectives

a. To provide end-to-end solution under various interventions

b. To enhance the income of rural Households at every level of intervention

c. To empower women through collective livelihood action

Implementation Framework

The grounding of Integrated Farming Cluster requires a step-by-step intervention in order to achieve desired goal and objective of providing end-to-end solution with diversified livelihood activities at the household level. The framework consists of:

Identification of Geography: The identification of geographical contour of a given integrated farming cluster is important in terms of approachability, common commodities, and similar social structure. The areas where there are significant possibilities for creation of livelihood assets through mission convergence with Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS), Ministry of Agriculture and Farmer's Welfare, etc. are preferred.

Identification of Households: The project beneficiaries would be drawn from existing SHGs, with those included in mission sponsored farm livelihood activities. The interested women farmers, being included in the IFC cluster, must have agriculture or livestock rearing as their core livelihoods. They should be actively involved with the Farmer Field School and may be a part of the existing producer group or producer company.

Commodity Identification: A study is conducted in the selected cluster area to assess the preliminary situation of the farmers and the level of agriculture in the area. The study will also help in identifying the potential products for promotion in the IFC cluster. It is to be carried out to help in generating data related to the current prevailing situation of farming and small, marginal, and tenant farmers. The purpose of study is to identify 2-3 commodities which are either universal among the intervention households or which can be easily adopted with good marketing potential. It is imperative to understand that as the interventions are across 2-3 commodities, the value chain for all the intervening households, their adaptability in each and every household is mandatory.

Placement of Human Resource: The guidelines have a provision for two dedicated human resources. These are an IFC anchor and a Senior Community Resource Person (CRP) to support the implementation of IFC. It is of paramount significance that both human resources are identified, trained and deployed for smooth running of the project.

The IFC anchor should preferably have a degree/ diploma in agriculture or allied sciences with a minimum of one year of experience in agriculture or farm-based livelihoods promotion. Experience in extension and marketing is given preference. In case there is a non-availability of a candidate with a degree in agricultural or allied sciences, a person with a regular Bachelor's degree and relevant experience in agriculture of 2 years may be considered for the position.

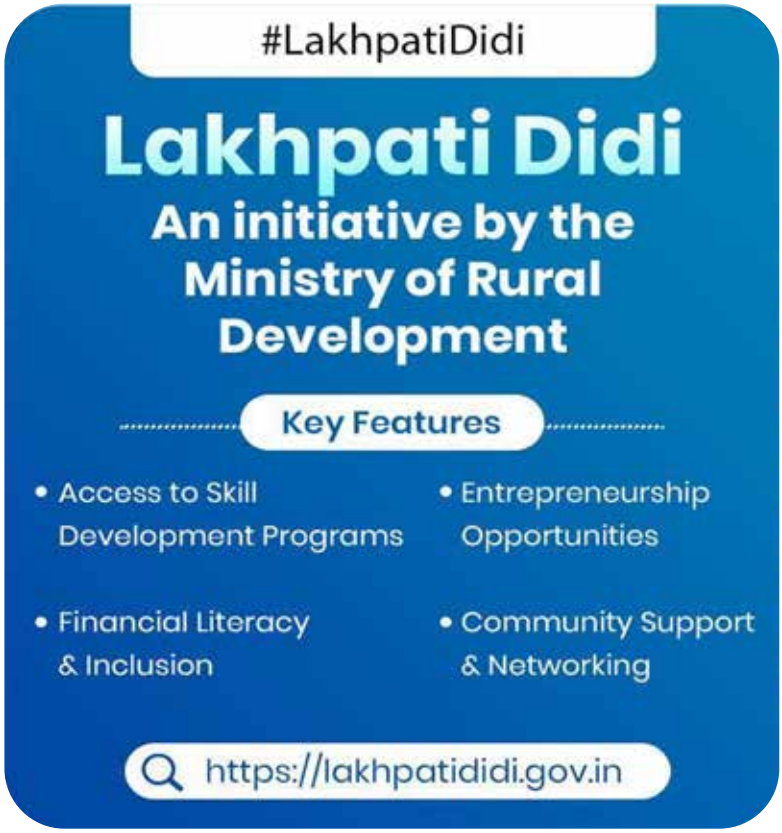
The Senior CRP can be experienced Krishi Sakhi, Pashu Sakhi, Van Sakhi, or Udyog Sakhi developed under DAY-NRLM. Senior CRPs should be selected from among those, who should be active for more than two years and are entrepreneurial. They should have demonstrated their abilities and underwent all the trainings as per the approved CRP modules developed by the National Mission Management Unit (NMMU).

Baseline Survey: An initial socioeconomic survey of the cluster is conducted. Baseline assessment covers a variety of factors to identify the potential interventions, plan development and business plan. This helps in establishing the base figures based on future outcome indicators that can be measured to understand the change contribution. The assessment will be conducted using stratified random sampling through structured household-level interviews and open-ended focus group discussions with a variety of stakeholders.

Development of Training & Capacity Architecture: Every Integrated Farming Cluster is unique in itself in terms of geography, climate, social and cultural norms, and intervention commodities. Hence, the training needs and approach are different in every cluster. It is thus important that training material is developed for CRPs, Mahila kisan households and concerned staffs looking at the needs and identified commodities. For this the support of associated Krishi Vikas Kendras / RCRC partners may be sought.

Business Plan for Commodity Wise Intervention: Business planning is an important aspect of IFC implementation. After the identification of 2-3 commodities for 250-300 households of a cluster, the plan needs to be developed for activities to be undertaken for each commodity in terms of production/ productivity, processing (Primary & Secondary), and marketing. While baseline assessment figures or secondary data may provide an important input to understand the level from which products and services for farmer members should be developed, however, more important will be collective visualisation of the marketing aspect. It is thus important to develop a proper business plan with projections on various aspects.

Livelihood Service Centre: This Centre is envisaged as a hub of input, processing and output services governed by Senior CRP**.** In progressive agriculture belts, private players offer different services, like input shops, agri-machinery, nursery, and seedlings, etc, similarly for a livestock clinic- feed, medicines, etc. These services are mandatory for cluster-based development. Hence, livelihood Service Centre is developed at the Cluster level



where some of these services could be made available to farmers at a reasonable rate. The anchor, Senior CRP and block mission unit manage these centres.

The farmers find it difficult to dispose of their produce, market at a distance of 40/60 kms increases cost and time spent selling their produce. The livelihood centre is expected to procure and do sorting, grading, bulk selling, and establishing linkages with the market. Private entrepreneurs and community enterprises in the form of Farmer Producer Organizations may also be leveraged in this regard. The components of Livelihood Service Centre based on the value chain gap analysis are as follows:

a. **Input**: The centre may serve as point of interaction for input activity such as seed, fertilisers, nursery, demonstration plot, deworming, vaccination, etc. based on the need assessment and scoping of the concerned households.

b. **Processing:** It has two components, viz., Primary and Secondary Processing. The need of processing unit is subject to commodity wise business plan based on need and community requirement, capacity utilisation of processing unit, optimum utilisation of aggregated resources in the processing centre and value achieved in terms of form, place and time. For instance, if a Livelihood Resource Centre is aggregating 100 tons of mustard and plans to set up 1-ton daily capacity oil mill, the total operation days will only be 100 days. What output you propose to get for the next 265 days? Can we go for 3rd party oil extraction? These questions need to be resolved by the centres.

c. **Output:** The planning of commodity-wise output activity is again dependent on its usage. The options at this level for market-side interventions are Producer Groups, Traders, Producer Enterprises, etc. The other intervention may include storage, primary value addition, etc.

d. **Marketing Side Intervention:** Three major categories of interventions possible are:

- **Commodities with Limited Scope for Post–Harvest Value Addition:** The intervention would be limited to pre-production, production, and post-harvest-upgrading and sorting of the commodity. May include drying wherever applicable. Investments may be required in the areas of sorting, grading, and drying equipment to the drying yards.
- **Commodities with a High Scope of Post-Harvest Value Addition**: The intervention will also include processing and packing in bulk and micro-packing. Investments required will be higher for establishing processing facilities and packing facilities. The IFC project does not intend to promote tertiary level processing.
- **Livestock Value Addition:** The investment will have to be made in establishing the traceability in improving the health of the animals through vaccination and scientific rearing.
- **Forming Producer Groups (PGs)**: If there are existing FPCs, the IFC project should collaborate with that entity. The existing Producer's group should be promoted for backward and forward linkages. Farmer's enrolment may follow the IFC. The PG members would attend livelihood visioning cum planning exercises with the help of CRPs, to identify a set of two to five economic activities per household. They should list existing issues and constraints, develop a strategy to address them, and provide the support required from the project. Each PG would create a theme-wise seasonal activity calendar, and the CRPs and IFC Anchor would be responsible for implementing the plan.

Financing

DAY-NRLM supports each IFC to the tune of Rs 40 lakhs whereas the further fund requirements have to be sustained through convergence with different line departments, support through CSOs, and private organisations by the respective State Rural Livelihood Missions.

Project Implementation

The project was initially conceptualised in 13 States which were supported through World Bank funded National Rural Economic Transformation Project (NRETP), viz., Assam, Bihar, Chhattisgarh, Jharkhand, Gujarat, Rajasthan, Madhya Pradesh, Maharashtra, Karnataka, Odisha, Tamil Nadu, Uttar Pradesh, and West Bengal. A total of 400 such clusters were sanctioned under the NRETP. Looking at their success and robust strategy, 6,000 more clusters have been approved under the Mahila Kisan Sashaktikaran Pariyojana, a sub-component under DAY-NRLM.

Success Story

In Kondagaon block of Kondagaon district of Chhattisgarh, the success of IFC cluster has shown exemplary result in terms of economic gain for 250 households spread across four villages. The four commodities identified for intervention were Maize, Vegetables, Non-timber forest produce, and backyard poultry. The end-to-end interventions across these commodities have resulted in increase in income from Rs 1,000 per month to Rs 12,000 per month per member. It has been on the record that planned interventions across 3-4 commodities have led to increase in food sufficiency of the household and has been major game changer in Lakhpati Didi Initiative.

Conclusion

Integrated Farming Cluster is a new and innovative concept introduced by DAY-NRLM with aim to provide sustainable and multiple livelihood options to the rural poor SHG households in a structured way. Since inception, due to proper planning and market-centred strategy, it has been able to induce confidence in the community and bring out entrepreneurial qualities of the individuals who are working as link point for different livelihood options across the value chain. This program can certainly be a milestone in enhancing income of women farmers much more than the vision of Lakhpati Didis. ❑

(The other contributing author is Dr. Vivek Kunj, National Mission Manager, Farm Livelihoods, NMMU, GoI)

Jugaad Innovations Transforming Rural India

Jugaad innovations are transforming everyday lives by providing affordable and sustainable alternatives in agriculture, healthcare, education, and energy. This transformation is not merely about survival but about thriving in adversity, showcasing the remarkable resilience and creativity of rural India. As the nation strides towards modernisation, these grassroots innovations stand as a testament to the power of indigenous knowledge and the indomitable spirit of its people, promising a future where rural India is not left behind but stands at the forefront of progress.

*** Dr. Riti Thapar Kapoor**

In the heart of India's vast rural landscape, a silent revolution is taking place, driven by the age-old innovation practices of "jugaad" — a term used for frugal innovation at grassroots level. These ingenious solutions, born out of necessity and resource constraints, empower rural communities, address their unique challenges, and bridge the socio-economic divide.

Jugaad innovations are transforming everyday lives by providing affordable and sustainable alternatives in agriculture, healthcare, education, and energy. This transformation is not merely about survival but about thriving in adversity, showcasing the remarkable resilience and creativity of rural India. As the nation strides towards modernisation, these grassroots innovations stand as a testament to the power of indigenous knowledge and the indomitable spirit of its

** The author is Associate Professor, Amity Institute of Biotechnology, Amity University, Noida, UP. Email: rititkapoor@gmail.com*

people, promising a future where rural India is not left behind but stands at the forefront of progress.

In rural India, jugaad innovations are catalysing transformative changes by harnessing the ingenuity of artisans, farmers, and *aam aadmi* to address local challenges with minimal resources. Jugaad innovations empower rural communities to create practical solutions tailored to their specific needs. Farmers, faced with resource constraints and harsh climatic conditions, are developing cost-effective agricultural tools like seed planters made from bicycle parts and irrigation systems from discarded PVC pipes. These innovations enhance productivity while reducing dependency on expensive machinery. Artisans, tapping into traditional knowledge, craft sustainable alternatives such as eco-friendly packaging and handmade machinery, which not only preserve cultural heritage but also offer eco-conscious solutions at a fraction of the cost.

Local entrepreneurs are repurposing waste materials into useful products, like turning plastic bottles into drip irrigation systems, which conserve water in drought-prone areas. These grassroots innovations exemplify a resilient and adaptive approach to problem-solving, leveraging local knowledge and resources. The National Innovation Foundation (NIF) India fosters grassroots innovation by scouting, supporting, and scaling up rural innovations to enhance livelihood opportunities and sustainable development across the country.

Let's discuss some jugaad innovations awarded by NIF India which are transforming rural India:

Multi-Purpose Food Processing Machine

Dharambir Kamboj from Damla village of Yamuna Nagar is only a 10th pass. Born in a small farmer family, Dharambir could not study much, but he started understanding the language of machines at an early age. While doing small jobs here and there, he used to make heaters and sometimes make and sell machines to people in the village. But the financial crisis at home was so severe that he had to go to Delhi to earn money.

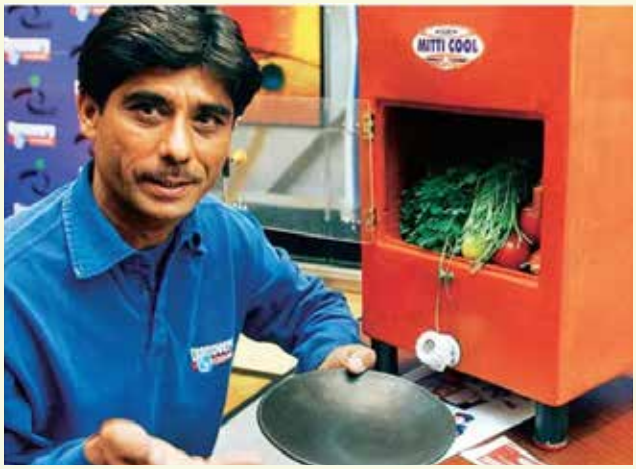
While going to Delhi, he had only 70 rupees in his pocket. He spent 35 rupees on fare and the rest on food. When he could not find any other work in Delhi, he rented a rickshaw and started driving it. He had no place to live or eat. Sometimes he slept on the footpath and sometimes on the platform.

The idea of making a machine came while doing farming when Dharambir returned to the village and started organic farming. He could not afford expensive fertilisers so he managed with cow dung manure. Luckily, he got the opportunity of a training on making rose water given by the Krishi Vigyan Kendra in the village. But now the question was where to get the machine for it? When he did not receive the proper answer of this question, he decided to make the machine by himself.

After months of hard work, Dharambir finally succeeded in making a multi-purpose food processing machine. The specialty of this machine is that it can process many types of fruits like aloe vera, rose, jamun, basil, guava, mango, orange, and other medicinal crops and make products like gel, juice, extracts, etc.

After making the machine, Dharambir started processing his crops himself and making products, which he started delivering directly to the market. When his work went well, other farmers asked him to make this machine. In this way, the National Innovation Foundation and Honeybee Network came to know about his machine. They checked the machine and found that through this machine, farmers can be made self-reliant. Dharambir not only got a patent for this machine but today his machine is also being exported to countries like Japan, South Africa, Kenya, Nepal, and Nigeria. He has got the opportunity to go abroad many times to give training to farmers and teach them how to process their crops.

In the next five years, Dharambir wants to sell his food processing system to over 100 countries, with a goal of boosting revenue to Rs. 2 crore this fiscal year and roughly Rs. 10 crore by the year 2027. Dharambir has sold over 900 machines, resulting in the employment of approximately 8,000 workers.



Mitticool, a refrigerator that runs without electricity

Mansukhbhai Prajapati from Gujarat began as a simple potter. In 2005, this potter was credited for a ground-breaking green innovation-Mitticool, a refrigerator that runs without electricity. It took him four years to get the combination right. In 2010, he found himself on the Forbes' list of Top seven Rural Entrepreneurs.

Clay products gradually get erased from our lives. Mansukhbhai Prajapati, a man with a vision, brought it back into the mainstream with innovative products. He has brought about a revolution with his endeavour to reconnect people with clay and soil. He is credited for his earthen clay-based functional products such as refrigerators, filters, tawa, and cookers among others, his work boasts of being high in efficiency and eco-friendly in nature. However, despite being born into a family of potters, his journey has been an arduous one.

Born to a poor potter's house on 19th October, 1970, Mansukhbhai's family had already quit their business due to the breakdown of the Machhu dam and thereafter migrated to Morbi.

Mansukhbhai joined a pottery firm as a learner in 1985. As he picked up the tricks of the trade, a business idea sparked in his mind. He started an earthen plate manufacturing factory by deploying a tile press rather than the traditional potter's wheel. Mansukhbhai quit his job, borrowed Rs. 30,000 from a moneylender, and bought a small piece of land to set up a workshop at Wankaner. When a businessman came looking for a vendor who could supply clay water filters, Mansukhbhai impressed him with an innovative terracotta filter with a ceramic candle and bagged an order worth rupees one lakh.

In 2001 Gujarat was hit by a massive earthquake. This was the inspiration that finally led him to develop a refrigerator Mitticool made out of clay. Mansukhbhai tried an unusual addition of sawdust and sand, which makes the soil porous and the interiors cold. During the Gujarat earthquake, journalists came and photographed the broken *matkas*. They referred to them as the poor man's fridge. Mansukhbhai thought why can't he make a real fridge with the same cooling principle? Mansukhbhai's initiative Mitticool keeps the water cool. Vegetables kept inside it can last up to a week. He also produces water filters, pressure cookers, and non-stick tawas made out of clay. Dr. APJ Abdul Kalam named Mansukhbhai as a 'true scientist', for his amazing inventions.

From selling handmade clay pots and pans in villages on an old bicycle to building a Rs.3 crore turnover company - Mitticool Private Limited - Mansukhbhai has come a long way.

Amphibious Bicycle that Floats on Water

The bicycle that runs on water was prepared by Mohammad Saidullah during the flood of 1975 at East Champaran of Bihar. A sailor had refused to board the boat during the flood without paying. Then Saidullah was determined and invented this bicycle. Necessity met creativity and in just three days, he made an amphibious bicycle that could easily negotiate the floodwaters.

He modified the conventional bicycle by adding four rectangular air floats to support it while it moved on water. The amphibious bicycle comprises

a conventional bicycle modified with two extra attachments that enables it to run on both water and land. The blades were arranged in such a fashion that the cycle could be driven in reverse direction too. The first attachment consists of four rectangular air floats, which support the bicycle while moving in water. These rectangular floats are in two pairs and each pair is attached to the front and rear wheel of the bicycle with a piece on either side of the wheel. These floats can be folded when the bicycle runs on land. These floats are lightweight and hence the cyclist does not feel any extra burden. He has also designed a similar rickshaw which was propelled by pedalling on water.

The advantages are obvious as people in rural areas need no longer solely depend on the few overcrowded boats for crossing the river. Further, crossing the river can be done at one's own convenience. As the bicycle operates on both land and water, the time and money required for hiring a boat to cross the river and for further transportation on land is saved.

Saidullah invented dozens of useful things including a hand-operated pump set, a fan, a mini tractor, a battery-operated bicycle and a bike. Saidullah made many unique inventions and for this he was honoured with the Grassroot Innovation Award in 2005 by the then President Dr. APJ Abdul Kalam. In 2005 itself, he was included in the list of 12 inventors for the Wall Street Journal Asian Innovation Awards. For a long time, Saidullah remained in the headlines of the country and the world media. He died in December 2023.

Bicycle Weeder – Krishiraja

Gopal Malhari Bhise's farm was 4 km away from the village in Jalgaon, Maharashtra, so he had to go there on a bicycle. One day he saw a person bringing four sacks of flour on a bicycle. Although it was a difficult task, the person was still doing it. That day he got the idea of using the bicycle for farming. To realise this idea, he removed the rear wheel of the bicycle and made a machine with every axle, wheel and handle, which could do farming without a tractor and bulls. Earlier, a little strength had to be used to run this device, but gradually by making improvements as per the need, he succeeded in developing the bicycle as a means of removing weed. This bicycle is also being used for ploughing the fields. He has named it 'Krishiraja'.

Bicycle weeder is a multipurpose farm implement developed by using inexpensive bicycle components. The main part of the implement consists of the front portion of a bicycle, namely handle bar, front axle and the wheel. A steel fork is connected to the axle and other end carries different attachments. Separate attachments for weeding and tilling are attached to the working end using bolts and nuts. This helps in changing the attachments as needed. The load in digging out the soil has been kept to the minimum by providing appropriate profiles and curvature to the implements. Suitable slots are provided for attachments so that the distance between the blades can be adjusted to suit specific requirements. Not all the farmers in the country can afford bullock, a small tractor or power tiller. Also due to relatively low land holding capacity many farmers do not need these farm equipment.

After a lot of trial and error, Gopal came out with an implement, fashioned out of the front axle, wheel and handlebar of a standard bicycle, that can be used by the marginal farmers to conduct operations normally carried out by bullocks or tractors.

His portable implement, christened 'Krishiraja', was received very well in the local market. He has fabricated 213 devices so far. The whole set currently sells for approximately Rs.1200 a piece. 'Krishiraja' makes a raja out of the marginal farmer.

Chandraprabha Water Gun or Rain Gun, a sprinkler

Annasaheb Udagavi, a farmer in Sadala village in Belgaun district, North Karnataka innovated Chandraprabha Water Gun or Rain Gun, a sprinkler, which washes away white flies and aphids from the tobacco plant. The sprinkler system is also useful in irrigating sugarcane.

He believed that the best method to save his crop was to wash down aphids and white flies with a high-pressure water spray. He switched over to sugarcane cultivation for better returns. Although he had dug another well for irrigating the sugarcane crop, the problem of salinity and the difficulty of irrigating the dense crop made him search for an alternative. And then the sprinkler irrigation system started taking shape.

Chandraprabha Water Gun or Rain Gun, a sprinkler covers as much as 140 feet radius to irrigate the sugarcane. Many years ago, when hardly anybody knew about drip irrigation, he thought of using it in his own way. To save his betel-vine orchard from the acute scarcity of water, he fitted PVC pipes, used in electrical fittings, after making perforations with nails. He spent Rs. 30,000 to cover two acres of betel-vine. By irrigating it for an hour every day, he successfully maintained the orchard for seven years.

The current situation of irrigation uses a large amount of water. For semi-arid and arid condition, water availability is quite low. Drip and sprinkler irrigation is efficient but difficult to irrigate long and dense crops in short duration. In Chandraprabha Rain Gun, the nozzle assembly has been separately given gear connections to the transmission, which is different from the existing sprinklers, single nozzle assemblies, which deflect the single water stream. The Chandraprabha Raingun is invented by Annasaheb Udagavi who could not attended any school. However, he designed and developed the Rain gun, which could do surface irrigation without making soil too wet, useful for the sugarcane crops.

Bullet Santi - Multipurpose Motorcycle Operated Farming Equipment

For farming operations, tractor is not an affordable option for farmers having small land holdings. Increase in the cost of fodder for bullock, regular occurrence of drought and shortage of farm labour forced Mansukhbhai Ambabhai Jagani, a farmer of Saurashtra area of Gujarat to look for an alternative to Bullock.

After 4-5 years of experiments, Mansukhbhai developed an attachment for a motorbike -- a multipurpose motorcycle operated farming equipment. This could be attached to any motorcycle by replacing the rear wheel with an assembly unit.

Using the self-fabricated chassis, drive and power of a motorcycle in front, Mansukhbhai has retrofitted an attachment with two wheels at the rear with a tool bar to fit various farm implements. The rear wheel of the motorcycle has been removed and an innovative assembly unit has been attached. It can also be designed and attached to locally available Chhakdo rickshaw or assembled vehicle having minimum 6.5 HP engine.

This meets various needs such as ploughing, weeding and sowing seeds and spraying. It can improve productivity and reduce operating costs for farmers, who currently use bullock-driven plough and cannot afford the tractors or power tillers. The farmers have immensely benefited from Bullet Santi. This innovation helped them to increase productivity as they do not have to worry about the labour cost or bullocks to plough.

Bullet Santi, which won a patent in India and the US, has been a blessing for hundreds of farmers in India. Santi, the cost-effective plough, is an ideal device for farming. It can plough one acre (0.4 hectares) of land in less than half an hour, using just two litres of diesel. Santi can de-weed in a typical field for just Rs.8 per hectare. This device considerably reduces costs for farmers, who cannot afford to buy tractors. The best part about the Santi is that the bike can be used for travelling once the field work is over. It takes about half an hour for this transition. The Santi costs about Rs.38,000.

Jugaad innovations have become a cornerstone in transforming rural India, driving economic growth, enhancing livelihoods, and promoting sustainable development. By leveraging local ingenuity and resourcefulness, these grassroots solutions address unique challenges and empower communities. As Jugaad continues to inspire creativity and adaptability, it paves the way for inclusive progress, proving that innovation can flourish even in resource-constrained environments, ultimately reshaping the future of rural India. Hats off to the rural innovators driving transformation and development in rural India, paving the way for a Viksit Bharat through their groundbreaking innovations.

An overview of innovations made for rural India over the past decade, supported by government sources and recognised reports:

Low-Cost Drip Irrigation

- Innovation: Utilisation of discarded PVC pipes and plastic bottles for drip irrigation.
- Impact: 50% increase in water-use efficiency.
- Source: Ministry of Agriculture & Farmers Welfare, Pradhan Mantri Krishi Sinchai Yojana (PMKSY) Report.

Bicycle-Powered Seed Planter

- Innovation: Modified bicycles for planting seeds efficiently.
- Impact: 40% reduction in labor costs.
- Source: National Innovation Foundation (NIF) - India.

Solar-Powered Grain Threshers

- Innovation: Use of solar energy to power threshing machines.
- Impact: 60% reduction in fuel costs.
- Source: Ministry of New and Renewable Energy.

Bio-Gas Plants Using Kitchen Waste

- Innovation: Conversion of organic kitchen waste into biogas for cooking.
- Impact: 30% reduction in LPG usage in pilot areas.
- Source: Ministry of New and Renewable Energy, National Biogas and Manure Management Programme (NBMMP).

Solar Lanterns and Chargers

- Innovation: Affordable solar lanterns and mobile chargers.
- Impact: Improved lighting and communication for 100,000 households.
- Source: Deen Dayal Upadhyaya Gram Jyoti Yojana (DDUGJY).

Water and Sanitation

- Community-Based Water Purification Systems
- Innovation: Low-cost, community-operated water purifiers.
- Impact: Safe drinking water for 250,000 people.
- Source: Jal Jeevan Mission, Ministry of Jal Shakti.

Eco-Friendly Toilets

- Innovation: Low-cost toilets using locally available materials.
- Impact: Improved sanitation for 500,000 rural residents.
- Source: Swachh Bharat Mission - Gramin (SBM-G).

Low-Cost Automated Irrigation Systems

- Innovation: Use of IoT devices and locally sourced materials for automated irrigation.
- Impact: Reduced water usage by 30%, increased crop yield by 20%.
- Source: Agricultural Technology Management Agency (ATMA) Annual Report 2023.

DIY Soil Health Monitoring Kits

- Innovation: Affordable kits made from easily available materials for testing soil nutrients.
- Impact: Improved soil management practices,

leading to a 15% increase in productivity.

- Source: Indian Council of Agricultural Research (ICAR) Report 2024.

Micro-Hydro Power Generators

- Innovation: Using locally fabricated turbines to harness small streams for power generation.
- Impact: Provided renewable energy to 25,000 households in hilly and remote areas.
- Source: Ministry of New and Renewable Energy (MNRE) Micro-Hydro Report 2023.

Biochar Stoves

- Innovation: Low-cost stoves that use agricultural waste to produce biochar, improving fuel efficiency and soil fertility.
- Impact: Reduced household energy costs by 40%, improved soil quality.
- Source: National Institute of Rural Development and Panchayati Raj (NIRDPR) Energy Solutions Study 2023.

DIY Water Filtration Systems

- Innovation: Affordable water filtration units using sand, charcoal, and locally available materials.
- Impact: Provided clean drinking water to 70,000 rural households.
- Source: Jal Jeevan Mission Innovation Report 2023.

Eco-San Toilets

- Innovation: Low-cost, ecological sanitation solutions using local resources.
- Impact: Improved sanitation for 100,000 people, promoting better hygiene and reducing water contamination.
- Source: Swachh Bharat Mission - Gramin (SBM-G) 2023 Report. ❑

Cultivating Progress
Enhancing Innovations in Rural India

The vision for a transformed rural India hinges on continuous innovation and inclusive growth. The goal is to create a resilient rural economy that leverages modern technology while preserving traditional strengths. By focusing on enhancing infrastructure, improving healthcare and education, and fostering entrepreneurship, rural India can become a powerhouse of sustainable development.

*** Dr. Naman Agrawal**

India, a land of vast contrasts, is home to over 1.4 billion people, with nearly two-thirds residing in rural areas. These rural regions, characterised by their agricultural dominance and traditional lifestyles, are undergoing a transformative journey. While the country has achieved significant economic growth, rural India remains a focal point for addressing developmental challenges and harnessing opportunities for innovation.

The Current Landscape

Rural India has seen a remarkable decline in poverty over recent years. The National Multidimensional Poverty Index (MPI) reveals a substantial reduction in poverty rates from 32.59% in 2015-16 to 19.28% in 2019-21. This decline is attributed to targeted government initiatives like the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA), Pradhan Mantri Awaas Yojana-Gramin (PMAY-G), and the Saubhagya Scheme for rural electrification.

** The author is Innovation Adviser, Embassy of the Kingdom of the Netherlands. Email: namanagarwal@minbuza.nl*

Despite these advancements, challenges persist. Rural areas still grapple with inadequate infrastructure, limited access to quality healthcare, and educational disparities. Approximately 35.5% of children under five years are stunted due to malnutrition. Additionally, the rural unemployment rate stood at 2.4% in 2022-23, indicating the need for more robust employment opportunities.

However, these challenges also present opportunities for innovation. The rise of digital technology, renewable energy solutions, and advancements in agricultural practices are transforming rural economies. The penetration of internet and mobile connectivity has surged, with 751.5 million internet users and 462 million YouTube users in India as of early 2024. This digital revolution is bridging the connectivity gap and opening new avenues for education, healthcare, and economic activities.

Government Initiatives and Innovations

The Indian government has been proactive in fostering rural innovation. The Pradhan Mantri Ujjwala Yojana (PMUY) has provided clean cooking fuel to millions of rural households, significantly improving health outcomes and reducing indoor air pollution. The Swachh Bharat Mission has enhanced sanitation facilities, with over 1,00,000 villages declaring themselves Open Defecation Free (ODF).

In agriculture, innovations such as precision farming, use of drones for crop monitoring, and genetically modified crops are boosting productivity and farmer incomes. For instance, the deployment of drones in Punjab for monitoring crop health has led to a 20% increase in yield and a 30% reduction in pesticide use.

Renewable energy projects are also making a significant impact. Solar microgrids in states like Rajasthan and Bihar are providing reliable electricity to remote villages, fostering economic activities, and improving the quality of life.

A Vision for the Future

Public-private partnerships are playing a crucial role in driving rural innovation. Collaborations between government bodies, private companies, and non-governmental organizations (NGOs) are creating sustainable development models. For example, the E-Choupal initiative by ITC Limited has revolutionised the agricultural supply chain by providing real-time market information to farmers, thereby enhancing their bargaining power and income.

The vision for a transformed rural India hinges on continuous innovation and inclusive growth. The goal is to create a resilient rural economy that leverages modern technology while preserving traditional strengths. By focusing on enhancing infrastructure, improving healthcare and education, and fostering entrepreneurship, rural India can become a powerhouse of sustainable development.

While challenges remain, the progress and potential for innovation in rural India are undeniable. The journey towards a prosperous and equitable rural India is underway, driven by strategic initiatives, technological advancements, and the unwavering spirit of its people. As we look ahead, the focus must remain on inclusive and sustainable growth, ensuring that the benefits of innovation reach every corner of rural India.

Agricultural Innovations: Sowing Seeds of Change

Agriculture remains the backbone of rural India, supporting nearly 70% of rural households. The sector is witnessing a transformative phase driven by technological advancements and innovative practices that promise to enhance productivity, ensure sustainability, and increase farmer incomes.

Precision Farming: The Rise of Smart Agriculture

Precision farming is revolutionising traditional

agricultural practices. By leveraging technologies such as GPS, IoT, and AI, farmers can optimise inputs like water, fertilisers, and pesticides. For example, soil sensors provide real-time data on soil health, allowing for precise fertiliser application. This not only enhances crop yield but also reduces environmental impact. In Maharashtra, the use of precision farming techniques has led to a 20% increase in crop yields and a 30% reduction in water usage.

Drones: The New Eyes in the Sky

Drones are increasingly being adopted for various agricultural applications, including crop monitoring, pesticide spraying, and soil analysis. The Indian government's Kisan Drone initiative aims to make drone technology accessible to small and marginal farmers. In Punjab, drones are used to monitor crop health and detect early signs of pest infestations, significantly reducing crop losses. These drones can cover an acre in just a few minutes, providing uniform pesticide application and reducing human exposure to chemicals.

Digital Platforms: Bridging the Information Gap

Digital platforms like the National Agriculture Market (eNAM) are creating a unified national market for agricultural commodities. eNAM connects farmers with buyers across the country, ensuring better price

for farm produce and reducing the role of middlemen. Since its launch, eNAM has facilitated the trade of over 100 million tons of produce, benefiting more than 17 million farmers. Additionally, platforms like Krishi Vigyan Kendras provide farmers with real-time information on weather forecasts, pest management, and best farming practices.

Sustainable Practices: The Push for Eco-Friendly Farming

Sustainability is at the forefront of modern agricultural innovations. Techniques such as organic farming, agroforestry, and the use of biofertilisers are gaining traction. In Andhra Pradesh, the Zero Budget Natural Farming (ZBNF) initiative encourages farmers to use locally sourced, natural inputs instead of synthetic chemicals. This has resulted in improved soil health and reduced input costs, with many farmers reporting a significant increase in net incomes.

Farmer Producer Organizations (FPOs): Strength in Numbers

FPOs are transforming the agricultural landscape by aggregating small farmers and enhancing their bargaining power. These organisations provide better access to inputs, credit, and markets. In Madhya Pradesh, FPOs have successfully negotiated higher prices for produce and facilitated bulk purchases of inputs at lower costs. Digital innovations have further strengthened FPOs by ensuring transparency and efficient management through electronic trading platforms.

Renewable Energy: Powering the Future of Farming

Renewable energy solutions, such as solar pumps and microgrids, are addressing the energy needs of rural farms. Solar-powered irrigation systems, for instance,

offer a sustainable and cost-effective alternative to diesel pumps. In Gujarat, the Suryashakti Kisan Yojana (SKY) has enabled farmers to generate their own electricity using solar panels, reducing reliance on grid power, and lowering electricity bills. The surplus energy is sold back to the grid, providing an additional income stream for farmers.

Innovative Startups: Catalysts for Change

Agritech startups are playing a pivotal role in bringing cutting-edge technology to rural farms. Companies like DeHaat and AgroStar offer comprehensive digital platforms that provide farmers with access to inputs, advisory services, and market linkages. These platforms use AI and big data analytics to offer personalised recommendations, helping farmers make informed decisions. The success of these startups underscores the potential of technology in transforming Indian agriculture.

The integration of technology and innovative practices in agriculture is paving the way for a more productive, sustainable, and profitable future for rural India. By embracing these advancements, farmers are not only enhancing their livelihoods but also contributing to the overall growth and resilience of the agricultural sector. The journey of agricultural innovation has just begun, with immense potential to further transform the rural economy and uplift the lives of millions of farmers.

Sustainable Livelihoods: Beyond Agriculture

Rural India is witnessing a transformative shift as innovative approaches to sustainable livelihoods are being embraced beyond traditional agriculture. These initiatives are designed to enhance income opportunities, promote environmental sustainability, and improve the quality of life for rural communities.

Decentralised Renewable Energy (DRE) Solutions

One of the most promising areas for sustainable livelihoods in rural India is the deployment of decentralised renewable energy (DRE) technologies. These technologies, such as solar pumps, dryers, and micro-grids, are creating new job opportunities and improving productivity. For instance, solar-powered dryers are helping farmers in Maharashtra preserve horticultural produce, reducing post-harvest losses and increasing income. Shivraj Singh Chouhan from Uttar Pradesh has seen his monthly income rise to INR 5 lakh through the use of solar dryers for drying flowers, sourced from over 100 farmers.

DRE technologies have the potential to impact 37 million livelihoods, generating revenue worth approximately USD 50 billion. The government's push through policy frameworks and financial incentives has been crucial in driving this adoption.

Water Management Initiatives

Effective water management is critical for sustainable livelihoods in rural India. Initiatives like the Jeevika program under the National Rural Livelihood Mission are championing women's involvement in water and sanitation projects. In climate-vulnerable regions, leveraging the expertise of local communities who have faced recurrent floods is essential. Programs like the "One Stop Shop" in Maharashtra train local youth as WASH Mitras (Water, Sanitation, and Hygiene workers) to maintain water infrastructure. This initiative not only provides essential services but also generates employment, with trained individuals earning around INR 12,000 per month.

Promoting Green Jobs

The Council on Energy, Environment, and Water (CEEW) is actively working to promote green jobs and sustainable livelihoods. Their initiatives focus on mainstreaming the economic potential of the clean energy transition, bioeconomy, circular economy, and nature-based solutions. By identifying opportunities for green jobs, informing policies, and developing market ecosystems, CEEW aims to support just and inclusive economic growth. The clean energy sector alone presents a market opportunity exceeding USD 50 billion, which can significantly boost rural incomes and employment.

Rural Technologies

Technological innovations are playing a pivotal role in enhancing sustainable livelihoods. Various technologies have been developed to ease the daily lives of rural inhabitants and reduce the technology divide between rural and urban areas. For example, efficient cereal threshers and harvesters, artificial glaciers in Leh-Ladakh to extend the agricultural season, and solar-powered devices for domestic needs are improving productivity and sustainability. These technologies are not only enhancing agricultural efficiency but also supporting small entrepreneurs and self-help groups (SHGs) in various sectors.

Empowering Rural Women

Empowering women through sustainable livelihood initiatives is crucial for holistic rural development. Programmes that focus on skill development and entrepreneurship among rural women have shown significant economic and social benefits. For example, involving women in the management and operation of water resources and renewable energy projects has improved service delivery and increased household incomes. Such initiatives not only enhance economic conditions but also promote gender equality and community development.

In conclusion, sustainable livelihoods in rural India are being significantly enhanced by the integration of renewable energy, water management, technological innovations, and the empowerment of women. These initiatives are creating diverse income opportunities, fostering sustainable development, and improving the overall quality of life in rural communities. By continuing to support and expand these innovative approaches, India can achieve inclusive and sustainable growth in its rural heartlands.

Renewable Energy: Powering Rural India

Renewable energy is becoming a cornerstone in the effort to empower rural India. With significant advancements and policy support, the adoption of renewable energy solutions is transforming rural landscapes by providing reliable power, creating jobs, and promoting sustainable development.

Solar Power: Lighting Up Rural Lives

Solar energy has emerged as a game-changer for rural India. The government's push through initiatives like the Pradhan Mantri Kisan Urja Suraksha evam Utthan Mahabhiyan (PM-KUSUM) scheme has been pivotal. PM-KUSUM aims to install solar pumps and grid-connected solar power plants in rural areas, reducing the dependency on conventional power sources and ensuring sustainable irrigation. As of 2024, India has installed over 82.63 GW of solar capacity, a significant leap from the mere 2.82 GW in 2014.

In states like Rajasthan, solar energy projects have made substantial impacts. Rajasthan leads with a renewable energy capacity of 17,040 MW, leveraging its vast arid lands for solar farms. These projects not only supply power to rural homes but also provide clean energy for agricultural purposes, enhancing productivity and sustainability.

Wind Energy: Harnessing Natural Power

Wind energy is another vital component of India's renewable energy strategy. States like Tamil Nadu and Gujarat have made significant strides in harnessing wind power. With targets to achieve 30 GW of offshore wind capacity by 2030, India is focusing on both onshore and offshore wind projects to meet its growing energy demands.

The hybrid approach of combining wind and solar power, promoted under the Wind-Solar Hybrid Policy, aims to maximise the use of transmission infrastructure and land, ensuring a more stable and reliable power supply. This approach helps in addressing the intermittency issues associated with renewable energy sources and provides a consistent energy supply to rural areas.

Decentralised Renewable Energy (DRE): Bridging the Last-Mile Connectivity

Decentralised renewable energy solutions, such as mini-grids and solar home systems, are crucial for remote and off-grid rural areas. The Ministry of New and Renewable Energy (MNRE) has been instrumental in promoting DRE through various frameworks and policies. These solutions provide reliable electricity to villages that are not connected to the national grid, improving the quality of life, and fostering economic activities.

In Andhra Pradesh, decentralised solar dryers have revolutionised agricultural processing by extending the shelf life of produce and reducing post-harvest losses. This not only ensures better prices for farmers but also minimises the reliance on diesel generators, promoting environmental sustainability.

Innovative Applications: Expanding the Horizons

The scope of renewable energy in rural India extends beyond electricity generation. Solar-powered cold storage units, for example, are helping farmers preserve their produce, reducing wastage, and ensuring better market prices. In regions like Bihar, solar irrigation pumps have enabled farmers to achieve higher crop yields by providing consistent and cost-effective water supply.

The National Green Hydrogen Mission is another ambitious initiative aiming to produce 5 million tonnes of green hydrogen annually by 2030. This mission is expected to revolutionise rural industries by providing clean energy for various applications, from transportation to manufacturing, thereby creating new economic opportunities and reducing carbon emissions.

Policy Support and Future Prospects

The Indian government's commitment to renewable energy is reflected in its policies and financial incentives. The Production Linked Incentive (PLI) scheme for solar PV manufacturing and the National Hydrogen Mission are significant steps towards achieving the target of 500 GW of renewable energy capacity by 2030. These initiatives are expected to generate substantial direct and indirect employment, further boosting rural economies.

Renewable energy is not just about providing power; it is about creating a sustainable and resilient rural India. By embracing solar, wind, and other renewable technologies, rural areas can achieve energy independence, enhance agricultural productivity, and improve the overall quality of life. The journey towards a greener and more prosperous rural India is well underway, driven by innovation, policy support, and the unwavering spirit of its people.

Policy and Institutional Support: Catalysing Innovation

The rapid advancement of renewable energy in rural India is underpinned by robust policy frameworks and institutional support, which are crucial for catalysing innovation and ensuring sustainable development. The Indian government has launched several initiatives and policies aimed at fostering

the growth of renewable energy, particularly in rural areas, to enhance energy security, reduce carbon emissions, and promote economic development.

The Ministry of New and Renewable Energy (MNRE) has been at the forefront of promoting renewable energy through various schemes and policies. One of the key initiatives is the Renewable Purchase Obligation (RPO), which mandates that a certain percentage of the total energy consumed by designated entities must come from renewable sources. The RPO targets are set to progressively increase, reaching 43.33% by 2030. This policy ensures a steady demand for renewable energy and encourages investment in the sector.

Additionally, the PM-KUSUM scheme (Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan) aims to provide solar-powered irrigation pumps to farmers, reducing their reliance on grid electricity and diesel. This initiative not only promotes clean energy but also helps in reducing operational costs for farmers, thereby increasing their income.

Financial Support and Incentives

Financial support is a critical component in the promotion of renewable energy. The Indian Renewable Energy Development Agency (IREDA) plays a significant role in providing financial assistance for renewable energy projects. In 2023, IREDA was granted 'Infrastructure Finance Company' status by the Reserve Bank of India, enhancing its ability to support large-scale renewable energy projects. The successful IPO of IREDA in late 2023, which was oversubscribed by 38.8 times, indicates strong investor confidence in the renewable energy sector.

The government has also introduced various financial incentives such as the Production Linked Incentive (PLI) scheme for high-efficiency solar PV modules. This scheme aims to boost domestic manufacturing of solar modules, reducing dependency on imports and fostering the growth of the renewable energy industry within the country.

Institutional Support and Capacity Building

Institutional support is vital for the successful implementation of renewable energy projects. The MNRE has established several autonomous institutions and public sector undertakings, such as the National Institute of Solar Energy (NISE) and the Solar Energy Corporation of India (SECI), to provide research, development, and deployment support for renewable energy technologies.

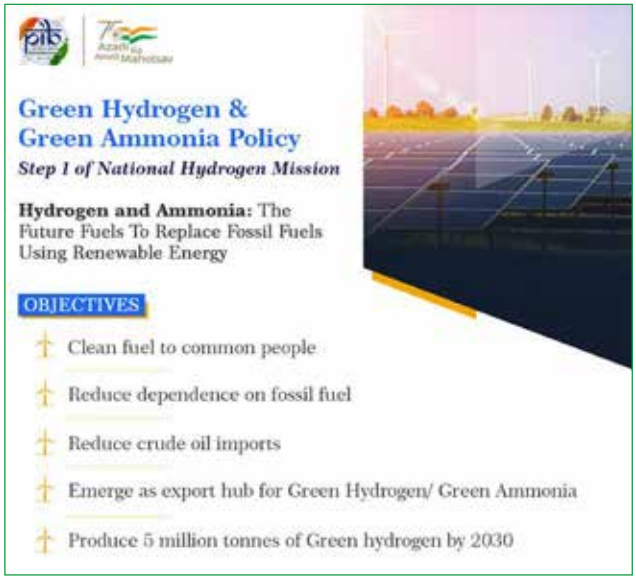
Capacity building is another crucial area, with the government partnering with institutions like Industrial Training Institutes (ITIs) to create a skilled workforce for green jobs. Training programs and technical assistance are provided to ensure that local communities can effectively manage and maintain renewable energy installations. This approach not only promotes sustainable energy but also generates employment opportunities in rural areas.

International Collaboration and Leadership

India's leadership in the global renewable energy landscape is also evident through its active participation in international platforms. India assumed the Presidency of the International Renewable Energy Agency (IRENA) in 2023, demonstrating its commitment to advancing global renewable energy goals. Additionally, under India's G20 Presidency, the Energy Transitions Working Group focused on addressing challenges related to energy security, accessibility, and sustainability.

Prospects and Challenges

While significant progress has been made, challenges remain in ensuring the widespread adoption of renewable energy in rural areas. Issues such as financing, standardisation of technologies, and integration of various renewable energy sources need continued attention. The MNRE's new framework aims to address these challenges by providing financial hand-holding support, promoting research



and innovation, and creating uniform standards and testing protocols for decentralised renewable energy (DRE) technologies.

In conclusion, the concerted efforts of the Indian government, supported by robust policies, financial incentives, and institutional frameworks, are driving the transformation of rural India through renewable energy. By continuing to build on these foundations, India can achieve its ambitious renewable energy targets and ensure sustainable, inclusive growth for its rural communities.

Challenges and Opportunities: Navigating the Path Forward

As India continues to push the envelope in renewable energy, especially in rural areas, it faces a myriad of challenges and opportunities. The transition to a sustainable energy future is complex, involving technological, financial, and infrastructural hurdles. However, with strategic planning and concerted efforts, these challenges can be transformed into opportunities for growth and innovation.

Challenges

Grid Integration and Flexibility: One of the significant challenges is integrating variable renewable energy (VRE) like solar and wind into the existing power grid. States rich in renewable resources, such as Karnataka, Tamil Nadu, and Gujarat, already face issues with grid stability due to the variability of solar and wind power. The Central Electricity Authority projects that by 2030, India will have 450 GW of renewable capacity, necessitating advanced grid management and flexibility solutions.

Financial Barriers: Financing remains a critical barrier for widespread adoption of renewable energy in rural areas. Although the cost of renewable technologies has decreased, initial capital investments are still high. Programmes like the Production Linked Incentive (PLI) scheme and the initiatives by the Indian Renewable Energy Development Agency (IREDA) provide some relief, but more needs to be done to ensure accessible and affordable financing.

Technological and Infrastructure Gaps: Rural areas often lack the necessary infrastructure to support advanced renewable energy systems. The deployment of decentralised renewable energy (DRE) solutions like mini-grids is hampered by the absence of robust local infrastructure. Additionally, there is a need for standardised and high-quality technology to ensure reliability and efficiency.

Policy and Regulatory Hurdles: Although there are numerous policies in place to support renewable energy, inconsistencies, and regulatory hurdles can impede progress. For example, Renewable Purchase Obligations (RPOs) mandate increasing percentages of renewable energy but require clearer implementation guidelines and enforcement mechanisms across states.

Opportunities

Advancements in Energy Storage: Energy storage technologies, particularly battery storage, are rapidly advancing and becoming more cost-effective. The integration of battery storage can mitigate the variability of renewable sources, ensuring a stable and reliable power supply. By 2040, India could see up to 200 GW of battery storage capacity, making it a global leader in energy storage.

Expansion of DRE Solutions: Decentralised renewable energy solutions offer a viable path to electrify remote rural areas. Mini-grids and solar home systems can provide reliable electricity to communities not connected to the national grid. These solutions not only improve living standards but also create local employment opportunities and foster economic development.

Green Hydrogen: Green hydrogen presents a significant opportunity for India to diversify its energy portfolio. Produced using renewable energy, green hydrogen can be used in various sectors, including transportation and industrial processes. The National Hydrogen Mission aims to make India a global hub for green hydrogen production, driving innovation and investment in this emerging field.

Policy and Institutional Support: India's policy landscape for renewable energy is evolving. Initiatives like the National Solar Mission and PM-KUSUM are crucial for scaling up renewable energy projects. The government's focus on creating a skilled workforce for green jobs and providing financial incentives through schemes like the PLI is also essential for long-term growth.

International Collaboration: India's leadership in international forums like the International Renewable Energy Agency (IRENA) and the G20

Energy Transitions Working Group enhances its ability to attract global investments and adopt best practices. Collaborative efforts can help overcome technical and financial barriers, accelerating the renewable energy transition.

While the path to a fully renewable energy-powered rural India is fraught with challenges, the opportunities for innovation, economic growth, and sustainable development are immense. By addressing these challenges with strategic policies, technological advancements, and international cooperation, India can pave the way for a resilient and sustainable energy future.

Conclusion: Vision for a Transformed Rural India

India's journey towards a renewable energy-powered rural landscape is both ambitious and achievable, driven by the synergy of policy initiatives, technological advancements, and community involvement. The vision for a transformed rural India encompasses economic growth, environmental sustainability, and enhanced quality of life for millions of rural inhabitants.

Economic Empowerment through Renewable Energy

Renewable energy is poised to be a catalyst for economic transformation in rural India. With the government aiming to install 500 GW of renewable energy capacity by 2030, rural areas are set to benefit immensely from this transition. The Production Linked Incentive (PLI) scheme for high-efficiency solar PV modules is a key policy driving this change, expected to generate over 1 lakh jobs and attract investments worth INR 93,041 crore.

Moreover, the expansion of decentralised renewable energy (DRE) solutions, such as mini-grids and solar home systems, is providing reliable electricity to remote areas, fostering local businesses, and reducing rural-urban migration. The successful implementation of mini-grid projects has already shown promising results, with rural communities experiencing improved economic activities and quality of life.

Environmental Sustainability and Climate Resilience

India's commitment to reducing its carbon footprint is evident in its ambitious targets: reducing carbon emissions by 1 billion tonnes by 2030 and achieving net-zero emissions by 2070. The widespread adoption of solar, wind, and other renewable energies plays a critical role in achieving these goals. Solar energy, in particular, is expected to see explosive growth, driven by the government's policies and the declining costs of solar technology.

The environmental benefits of renewable energy are manifold. By replacing diesel pumps with solar-powered ones through initiatives like the PM-KUSUM scheme, India is not only reducing greenhouse gas emissions but also promoting sustainable agricultural practices. Additionally, integrating renewable energy with agriculture through solar irrigation systems and solar dryers enhances productivity while minimising environmental impact.

Enhancing Quality of Life

The deployment of renewable energy solutions in rural India goes beyond economic and environmental benefits; it directly impacts the quality of life. Reliable electricity access improves healthcare services, educational opportunities, and overall living standards. For instance, solar-powered cold storage units help farmers preserve their produce, reducing post-harvest losses and ensuring better market prices, thereby increasing their income and food security.

Furthermore, renewable energy initiatives are fostering gender equality and social inclusion. Programs that train women in managing and operating renewable energy systems empower them economically and socially, creating more equitable communities.

The Road Ahead

While the path to a fully renewable-powered rural India is challenging, the opportunities it presents are immense. The key to success lies in continued policy support, innovative technological solutions, and active community participation. Ensuring financial accessibility through initiatives like collateral-free loans and integrating renewable energy projects with existing rural development programs will be crucial.

India's vision for 2030 is clear: a renewable energy-dominant landscape that drives economic growth, ensures environmental sustainability, and enhances the quality of life for its rural population. By embracing this vision, India can set a global example of how sustainable energy practices can lead to inclusive and resilient development. The journey towards a transformed rural India is well underway, and with sustained efforts, the dream of a green and prosperous future can become a reality. ❑

Adoption of Digital Technology in Rural Areas of India

Digital technology has brought about significant transformations in the lives of people, particularly in rural areas, by empowering and connecting them. The role of Digital India Programme has been instrumental in this as it helped provide increased access to technology in rural regions through high-speed internet networks, enhancing digital literacy, leveraging cutting-edge technology leading to a transformation of the rural service industry.

"We are the world's No. 1 in digital transactions; we have the most inexpensive mobile data. Today, India has more rural internet users than urban users"

—Prime Minister Narendra Modi

*** Rajiv Theodore**

Recognising the potential for economic growth through information and communication technology (ICT), the government is positioning itself as a significant player at the global digital transformation platform. Enroute to becoming one of the key digitally transformed nations, India is offering evident benefits to all its citizens in the urban as well as the vast population residing in its rural areas, as exemplified by Digital India Program (DIP), is explicitly linked to inclusiveness. The DIP's efforts to provide digital access, resources, and services to all, especially those in rural areas, emphasise this inclusivity—today over 6 lakh km of optic fibre has been laid connecting almost 2 lakh gram panchayats. By bridging the digital divide, offering digital literacy, and promoting cashless transactions, digitalisation contributes to a more inclusive and empowered society by ensuring that even marginalised communities can benefit from digital technologies.

** The author is senior Delhi based journalist. Email: rajivtheodore@gmail.com*

Strategy

The government has implemented strategies to transform the nation and create opportunities for its citizens through the utilisation of ICT tools, leading to the launch of the DIP initiative. The programme, initiated by Prime Minister, Shri Narendra Modi has embarked on a grand plan to empower India digitally and generate prospects for its citizens through the harnessing of digital technologies. The programme zeros in on three key areas: (1) digital infrastructure as a core utility to every citizen, (2) governance and services on demand, and (3) digital empowerment of citizens.

The programme is geared to provide high-speed internet access, mobile phones, and bank accounts to enable larger participation, easy access to Common Service Centres, and shareable private space on a public cloud. DIP aims to ensure that all government services are available electronically through an enhanced and effective online infrastructure. By increasing internet connectivity and empowering the country with digital technologies, the Indian government aims to achieve electronic governance (e-governance) of public services, leveraging innovative ICT tools.

It would make -

- Citizen entitlements portable and available on the cloud
- Promote electronic and cashless financial transactions
- Integrate services seamlessly across departments
- Providing real-time availability of services through online and mobile platforms.
- It involves popularising universal digital literacy, collaborative digital platforms for participative governance, the availability of digital resources and services in Indian languages, and eliminating the need for physical submission of government documents or certificates.

Adoption

Thanks to the ongoing digital revolution, India's internet presence is today higher in rural India than in urban areas (rural India has a 20% higher presence of internet users than urban parts of the country). The penetration of smartphones, UPI, and government schemes such as the Pradhan Mantri Gramin Digital Saksharta Abhiyan, have facilitated internet access in

remote parts of India. Numerous corporates, non-profits, and educational startups are reaching rural India with skill training, health and nutrition awareness, self-help group (SHG) empowerment programs, and more, by leveraging video conferencing and other technological platforms.

Some sectors enabling rural populations with opportunities through digitisation :-

Education

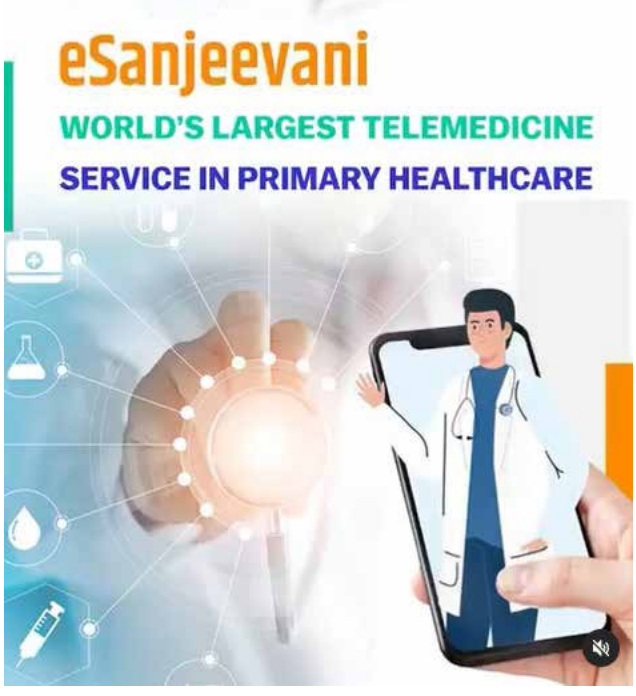
The Indian edtech market is gaining a strong foothold in rural areas too. The government had introduced free digital e-learning platforms such as Diksha and E-Pathshala offering learning material, school curriculum to teachers, students, and parents. E-Pathshala developed by NCERT hosts educational e-resources including textbooks, audio, video, periodicals, and a variety of print and non-print materials through website and mobile app. Collectively the available apps offer host explanation videos, e-books, and interactive lessons, in 12 to 15 Indian languages -- a significant step towards an inclusive education.

Health

The Indian digital healthtech that has a potential to generate $37 billion in revenue by 2030 today

Nurses and ASHA workers examining a resident of Awang Wabagai, Manipur

utilises NGOs, the private sector, and government through a competent network of -- Accredited Social Health Activist (ASHA)-- a network of community health workers employed by the Ministry of Health and Family Welfare. The *eSanjeevani app* (a national browser-based application facilitating doctor-to-doctor and patient-to-doctor tele-consultations) has facilitated over five million tele-consultations and was a boon during the pandemic, especially in rural areas. Through eSanjeevani OPD, one can seek medical advice as well as medication through audio and video. In addition to all this, startups have facilitated digitisation of single medical stores enabling patients in remote areas to access medicines.



Agriculture

Around 70 percent of India's rural households depends on agriculture, according to the Food and Agriculture Organization (FAO). Therefore, agritech is naturally drawing interest from farmers, governments, and private startups. Many startups are developing AI-enabled technology and apps to provide end-to-end solutions, which include soil testing, microfinance, weather updates, and more. An example in this direction is the Karnataka government's e-Sahamathi app which was developed by the e-governance department and the National Informatics Centre (NIC). Under this app, farmers must agree to share their crop information with the aggregator which, in turn, share details such as a farmer's name, his crop, landholding, etc. with the retailer. In essence, allowing the farmers to list their produce and directly sell it to retail chains—giving them the power to negotiate a fair price for their harvest. Multiple startups have created similar marketplaces.

Economic Empowerment

The e-Shram portal of the Ministry of Labour and Employment, a digital database of unorganised workers, is a fine example of a digital upgrade. The portal allows construction and migrant workers to

access job opportunities and provides social security to workers, offering a pension after the age of 60 Years with a Shramik Card. Given the unregulated nature of these markets, this is a great way to ease the process of seeking and employing skilled labour. Besides employment creation, the digital revolution has created opportunities for economic activities in rural India by making them an integral part of the market value chain for products and services—both as suppliers and consumers. The Jan Dhan Account-Aadhaar-mobile connectivity or JAM trinity, has further boosted the initiative.

Women Empowerment

The government is committed to its mission of empowering rural women, not only through loans and subsidies, but also by equipping them with new technologies to boost their confidence. NaMo Drone Didi, which trains women to pilot drones in villages to spray pesticides and fertilisers on crops is a big step in the direction. Despite constituting approximately 40 percent of the rural workforce, the contributions of women in Indian agriculture have historically been undervalued. Reports indicate that female farmers now make a substantial contribution to GDP per capita. However, their invaluable contributions often fade into the background in the male-dominated agricultural narrative. Digital platforms can bridge knowledge gaps by providing women with access to information that was historically challenging to obtain. Precision farming tools such as sensors and drones optimise resource utilisation, thereby enhancing efficiency and increasing yields. Technology facilitates direct market access and enables women to sell their produce at fair prices without relying on intermediaries.

Challenges

Like all sincere attempts to provide facilities there are certain challenges in the process:

- A persistent challenge is the last-mile connectivity in remote and rural areas, where infrastructure development is more challenging due to geographical and logistical constraints.
- The affordability factor for internet and digital devices remains a barrier for certain sections of society, limiting their access to the benefits of digital technologies.
- There is a scarcity of empirical studies specifically focused on rural areas, hindering a comprehensive understanding of the extent of digital information access and technology innovation among rural populations.
- Existing research predominantly concentrates on urban areas or provides a broader overview of the digital landscape in the country.
- There is a need for comprehensive frameworks that can systematically analyse the factors influencing the adoption and utilisation of digital information and technological innovation in rural areas.

Addressing these challenges requires a multi-faceted approach involving government, private sector, and civil society collaboration. Continued investment in digital infrastructure, expanding internet connectivity, and reducing the digital divide should be priorities. Simultaneously, efforts should focus on enhancing digital literacy and skills development programmes to ensure the sustainability of the Digital India campaign in rural India. Also, scientific research is needed to understand the extent of digital information access and technological innovation among rural populations.

Digital Empowerment of Rural India

Digital technology has brought about significant transformations in the lives of people, particularly in rural areas, by empowering and connecting them. The role of DIP has been instrumental in this as it helped provide increased access to technology in rural regions

through high-speed internet networks, enhancing digital literacy, leveraging cutting-edge technology leading to a transformation of the rural service industry:

- It has given the much-needed fillip to IT training for students and villagers, equipping them with the necessary skills for employment in the ICT sector.
- Rural residents have been trained by telecom service providers to address local internet needs, resulting in the creation of job opportunities in the service industry.
- One of the key impacts of DIP in rural areas has been the creation of community internet awareness. With the majority of Indians residing in rural regions, internet connectivity has played a crucial role in transforming these areas into digitally empowered societies, ensuring that everyone has access to the internet.
- The program has enabled rural communities, many of whom are economically disadvantaged, to access wireless internet, utilise digital platforms, and efficiently leverage e-Services.
- This initiative has not only reduced the reliance on paper-based processes but has also resulted in significant resource savings for poor rural communities.
- By spending less time and money on accessing services, these communities contribute to a cleaner environment and promote sustainable practices.
- DIP has extended its benefits to farmers by offering them digital services. This virtual platform has connected farmers to national agricultural markets and provided access to technological advancements.
- Farmers can access information on crop prices through mobile phones, enabling them to make informed decisions and optimise their agricultural practices. This integration of technology in the agricultural sector has opened up opportunities for increased productivity and income generation among rural farmers.
- DIP has also played a crucial role in driving economic growth, both in rural and urban areas. Government initiatives under the program, such as economic reforms, digitisation, and smart cities, have attracted foreign direct investments (FDIs) and facilitated relaxed economic policies.
- DIP has facilitated real-time education for rural communities, addressing the issue of teacher scarcity in India's education system through smart and virtual classrooms. Mobile devices have also been utilised to educate farmers and fishers on intelligent farming and fishing techniques, enhancing productivity and livelihoods.
- The availability of high-speed internet connectivity in rural areas has facilitated access to online education platforms, bridging the digital divide and providing supplemental educational resources to rural communities.
- The program has not only created job opportunities in the service industry, but has also facilitated the growth of businesses in rural and urban areas alike.

Conclusion

The effort to adopt digitalisation by the government has enhanced connectivity in rural India, bridging several gaps and enabling individuals and communities to access digital services and information. With community internet awareness, rural areas are fast transforming into digitally empowered societies where wireless internet and e-services have become accessible.

This has led to increased efficiency, reduced costs, and improved access to essential services for rural communities, ultimately contributing to their overall development. The BharatNet project aims to connect rural areas with high-speed broadband networks, providing access to digital services and empowering communities with knowledge and information. Bharat Sanchar Nigam Limited (BSNL) rolled out a notice inviting tender for the prestigious BharatNet – III programme to provide last-mile connectivity as well as upgrade existing 164,000-gram panchayats (village blocks) and connect 47,000 of them under the new model, based on ring topology.

Additionally, initiatives like the Pradhan Mantri Gramin Digital Saksharta Abhiyan (PMGDISHA) have been instrumental in imparting digital literacy skills to rural populations, enabling them to leverage digital tools for personal and professional growth.

By aligning with international service standards and promoting a tech-empowered society, India has positioned itself as an attractive destination for global investments, leading to economic modernisation and improved export capabilities. ❑

Innovations: Driver of Rural Growth and Development

Rural development is the cornerstone of economic and social progress in many countries around the world. India, a country with a substantial rural population, has long recognised the importance of rural development as a key driver of national progress. With nearly 65% of its population residing in rural areas, the need to enhance the quality of life in these regions is paramount. Innovations in various sectors are game-changers, propelling rural development forward in unprecedented ways. This article explores some of these groundbreaking innovations and their impact on rural India.

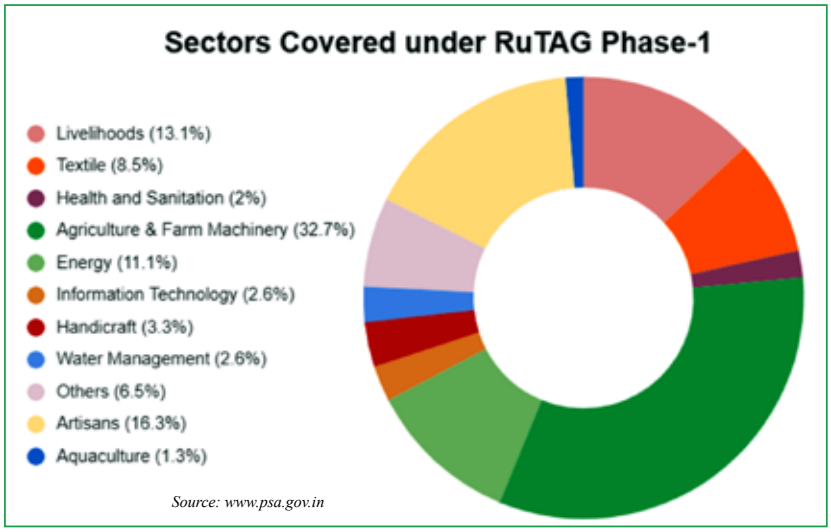
* **Arvind Kumar Mishra**

Agricultural and Allied Innovations

With the Research and Development (R&D) push in the Indian economy, the agricultural sector is embracing new innovations and technologies. These innovations and technologies not only improve efficiency but also address existing challenges and support livelihoods. A few of the recent innovations in agricultural sector include the Soil Health Card (SHC), which helps producers understand the fertility status of soil on which and with which they are working so as to promote judicious use of supplementary nutrition in the form of inorganic or organic fertilisers and thereby curtail the indiscriminate use of chemicals on soil. Wherever, used in the right way, SHC is not only helping in maintaining soil fertility in the long run but also cutting down the cost of fertilisers and promoting savings.

The National Agricultural Research and Education System (NARES), which comprises of Indian Council of Agricultural Research (ICAR) and State Agricultural Universities (SAU), is the primary force to push

* *The author is senior journalist. Email: arvindmbj@gmail.com*



agricultural innovations in the rural areas. Some of the prominent innovative technologies of NARES include the Sensor-Based Soil Moisture Meter, which senses soil moisture and automatically irrigates the field when the soil feels thirsty. Another innovative technology is the Leaf Colour Chart (LCC), which is helping farmers in understanding the nutritional needs of their crops at different stages of growth. The Pusa Decomposer is another innovation that helps in rapid situ decomposition of paddy residues, thereby helps in promoting cleaner environment by curtailing the incidences of crop residue burning on one hand and, on the other hand by improving soil fertility. Further, Happy Seeder is yet another innovation from one of the leading SAU in northern India. Happy Seeder is the in-situ paddy residue management technology that helps in the timely sowing of wheat, saves irrigation water, and reduces environmental pollution. The Evaporative Cooling unit is another innovation which helps the farmers in keeping their fruits and vegetables fresh even during the high temperature and thereby safeguarding them from incurring monetary losses due to deterioration in the quality of produce.

To encourage innovation in rural India, the Central Government is running several programmes at the policy level. Among these, the Rural Technology Action Group (RuTAG) started by the Principal Scientific Advisory Council (PSA) of the Government of India in 2003, is a major initiative. In this regard, various Indian institutes of technology in the country are refining innovations related to rural activities like agriculture work, fertiliser production, agricultural storage, weaving, biofuel, soil testing, renewable energy, and recycling at the rural level. In the first phase of the RuTAG, agreements have been signed with 752 NGOs on 358 innovation projects. In the first phase, 59 innovations that give impetus to the rural economy have been successfully tested and practically brought to the implementation stage. The RuTAG center identifies the need for innovations among specific rural geographical areas and communities and presents innovative solutions accordingly. It is also helpful in expanding scientifically recognised innovations. It inspires the development of scientific methods in the rural community.

The evaporative cooling unit has been developed by IIT Roorkee. Due to high temperatures during the day, the rate of spoilage of vegetables sold in the market increases two to three times. In such a situation, it is challenging to maintain the quality of vegetables. The evaporative cooling unit introduced by IIT Roorkee is an environmentally friendly innovation. It works on the principle of evaporation. In this, the place where vegetables are stored is kept cool. This keeps the vegetables moist for a long time. A battery has been installed to power the DC fan to provide cool air in the storage area of the unit. Foggers have been installed to maintain humidity. This can save vegetables from spoiling in rural and urban areas.

The Portable Oil Extractor (POE) is yet another innovation from RuTAG center of IIT Kanpur. It is energy and cost-efficient. Being portable in nature, the POE can be a means of entrepreneurship in the oilseed crop-producing region.

Innovations in the form of varietal technologies for the range of agricultural crops (field crops, horticultural crops, fodder crops, etc.) are another driver of promoting rural development through supporting higher production in rural regions and thereby promoting income and livelihood growth. High Yielding Varieties (HYV) of various crops is innovation which strengthens not only the rural regions but whole nation in the arena of food security. However, educated, high-income, and health conscious consumers create the demand for specific agricultural produce. In this area,

Biofortified Crop varieties are helping the rural areas and societies in combating nutritional insecurities. Currently, another innovation in the form of Herbicide Tolerant Crops offers farmers the flexibility to apply herbicides only when needed. It is a vital tool to control broad spectrum of weeds.

Digital innovations are turning the soil hard in rural areas, which were usually considered technologically backward. In the recent past, the digital revolution brought by the internet-based mobile phone is noteworthy in bridging the spatial, technological, and informational gaps. Today, several digital innovations are changing the lives of rural India. Farmers are getting improved agricultural inputs at their doorstep via online shopping; they are empowered to identify the problems in their field and timely address them by using some of the image-based apps. In this sector, ICAR and SAUs have developed several crop-specific (RiceXpert) and purpose-specific mobile apps (nXpert). Artificial Intelligence based Disease Identification System for Crops (AI-DISC) is yet another innovation by ICAR which is helping farmers in taking appropriate actions timely. Further, e-National Agricultural Market (e-NAM) is yet another digital innovation which is

changing the landscape of agricultural marketing in India. Now farmers can sell their produce at more competitive price to the distant buyers. Market Mirchi is another online portal from IIT Bombay which assists Farmer Producer Organisations (FPOs) and Self Help Groups (SHGs) in the direct sale of their produce to consumers by eliminating middlemen and thereby improves marketing efficiency. The special thing is that information related to employment at the rural level is also displayed in Market Mirchi. It has been designed in such a way that even educationally weak people can operate it easily.

Further, in the animal husbandry sector, Mobile In-Vitro Fertilisation (IVF) unit is yet another innovation which helps in enhancing accessibility and multiplication of superior germplasm. Through Gujarat's Amreli, India got its first mobile IVF unit. Automated milking and shearing machines are another means to reduce the drudgery of animal owners and discomfort to the animals. Cage Farming is yet another innovation for the coastal fishermen, which helps them in increasing the production of seafood.

Entrepreneurial Innovations

Innovation-driven entrepreneurship is a key catalyst for rural development. The rise of agri-tech start-ups and rural enterprises is creating jobs and stimulating economic growth. Government schemes like Start-up India and the MUDRA loan scheme are providing the necessary financial support and infrastructure to nurture rural entrepreneurs. Social enterprises focusing on rural markets are addressing local challenges with innovative solutions. From providing affordable healthcare and education to promoting sustainable agricultural practices, these enterprises are making a significant impact on rural communities. Ninjacart is one such innovation which offers multiple farmer's produce to retailers and local restaurants. AgriTourism and Home Stays are yet another innovation in attracting the higher income urban class to have a first-hand experience of rural life and providing urban like hospitality amenities among the nature in the rural areas. Villagers providing homestay facilities in Orchha, Ujjain, Maihar, Amarkantak, and Dewas districts of Madhya Pradesh are also being trained by the Hotel Management Institute, Bhopal. The Chhattisgarh government is developing wedding destinations in tribal-dominated districts of Bastar and Surguja Region. Jabra village in Chhattisgarh's Dhamtari district attracts a large number of foreign tourists. Uttarakhand, famous for its biodiversity, has brought the Rural Business Incubator facility to make homestay facilities in rural areas qualitative. The state government is also providing subsidy to the villagers providing homestays to develop facilities.

Custom Hiring Centres (CHC) across the country are yet another entrepreneurial innovation which engages youths in creating networks with the owners of agricultural machines and supplying these machines to the farmers in need for getting some monetary gains. Such CHC are not only bringing advanced technologies to the doorstep of farmers but also reducing the drudgery of agriculture, enhancing efficiency in production and creating rural employment. Drones are being used extensively in agriculture. They are useful in crop monitoring, surveys, and the application of inputs over a shorter period with higher accuracy. There are a few firms that provide custom hiring services of drones to the farmers.

Digital Innovations

The digital revolution has made substantial inroads into rural India, bridging the urban-rural divide. The Government of India's Digital India initiative aims to ensure that digital services are accessible to all citizens. E-governance services, digital payments, and online education platforms have reached rural areas, empowering residents with information and opportunities.

Mobile banking and fintech solutions like Unified Payments Interface (UPI) have revolutionised financial inclusion, making banking services accessible to the unbanked population. This has not only facilitated savings and investments but also fostered entrepreneurial activities.

Digital inclusion is being prioritised by the Central Government to encourage innovation in the rural sector of the country. The 5G Intelligent Village initiative will use the potential of 5G technology in the development of rural communities. Dharmaj (Anand, Gujarat), Ramgarh (Gorakhpur, Uttar Pradesh), Anandpur Jalbera (Ambala, Haryana), Bazargaon (Nagpur, Maharashtra), Bhagwanpura (Bhilwara, Rajasthan), Dabbong (Nagaon, Assam), Ravasar (Ashoknagar, Madhya Pradesh), Ari (Guna, Madhya Pradesh), Banskhedi (Shivpuri, Madhya Pradesh), and Burgipalem (Guntur, Andhra Pradesh) villages will be equipped with 5G Intelligent Village facilities.

The Meghdoot and Damini App launched by the Ministry of Earth Sciences have also brought innovation in the agriculture sector. The Meghdoot App assists farmers in getting accurate weather-related information, while the Damini app helps in preventing loss of life and animal loss due to lightning.

Innovations in Education and Skill Development

Education is a cornerstone of rural development. Innovations in this domain, such as the use of digital classrooms and online learning platforms, have democratised access to quality education. Initiatives like the National Digital Literacy Mission aim to make at least one person in every household digitally literate, fostering a culture of continuous learning.

Skill development programs tailored to the needs of rural youth are creating pathways to employment. Programs like Pradhan Mantri Kaushal Vikas Yojana (PMKVY) offer vocational training in various trades, equipping the rural workforce with skills that meet industry demands.

Healthcare Innovations

Healthcare in rural India has seen significant improvements due to innovative approaches. Telemedicine and mobile health clinics have made healthcare services accessible to remote areas. These services allow patients to consult doctors and receive medical advice without having to travel long distances.

Additionally, innovations like portable diagnostic devices and low-cost medical equipment have enhanced the quality of healthcare. Programs focused on maternal and child health, vaccination drives, and awareness campaigns on hygiene and sanitation are making a tangible impact on public health.

Innovations in the Energy Sector

Energy access is crucial for rural development. Innovations in renewable energy, particularly solar and wind power, are transforming the energy landscape in rural India. Solar lanterns, home lighting systems, and mini-grids are providing reliable and affordable electricity to villages, reducing dependence on conventional energy sources.

Initiatives like the Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan (PM-KUSUM) scheme promote the use of solar energy for irrigation, helping farmers reduce costs and improve productivity. These renewable energy solutions are not only environmentally sustainable but also economically viable, promoting overall rural development.

Institutional Innovations

In addition to the sectoral innovations that are transforming the landscape in rural India, innovations in the institutional domains are also contributing to rural transformation and development. Some of these institutional innovations include the Farmer Producer Organisation (FPOs) which support the small and marginal farmers with end-to-end services covering almost all aspects of cultivation, from inputs and technical services to processing and marketing. Self Help Group (SHG) is another institutional innovation which brings together people with similar interests

or problems and helps in addressing them through mutual help. Further, the GS Nirnay is a free android app developed by the Ministry of Panchayati Raj for recording and documenting proceedings of Gram Sabha. It is designed to help with the National Initiative for Rural India to Navigate, Innovate, and Resolve Panchayat Decisions. Sarpanch Samvad, developed by the Quality Council of India, is also an important innovation to increase the efficiency of Gram Sabhas. In this, Sarpanchs and Panchayats from all over the country associate and share best practices and exchange experiences in the implementation of schemes. Water budget audit is yet another institutional innovation for resource auditing and conservation. It is being adopted for water conservation in Khargone district of Madhya Pradesh. Here, the district panchayat will keep a complete record of how much water the village received, how much water was used and how much wasted. At present, this scheme has been implemented in Rasagangli, Chiklavas, and Gadgyam of Jhirnya in the district as a pilot project. This year, there are preparations to implement this innovation in 600 villages of the district. Under this, data of water inflow, use, and wastage in the village is collected. Keeping in mind the availability and water use, contour (water conservation by making a structure like stairs in the hilly area), use boulder (water conservation by depositing stones and gravel on the drain), check dam, stop dam and pond will be constructed. Earlier, by implementing a water budget, Kerala has become the first state in the country which makes activities like agriculture, horticulture, gardening, and plantation effective by making a budget to deal with the water crisis in summer.

Conclusion

The convergence of innovative technologies, government initiatives, and community participation is paving the way for holistic rural development in India. These innovations are not only addressing the traditional challenges faced by rural areas but also unlocking new opportunities for growth and prosperity. By continuing to foster innovation and investing in scalable solutions, India can ensure that its rural population is not left behind in its journey towards becoming a global economic powerhouse. The future of rural India is bright, and with sustained efforts, it will continue to shine even brighter. ❑

Rebooting Operation Flood through Automation

Modern technology has brought about a dramatic change in the dairy farm industry in recent years. These developments have completely changed the way dairy farms run their operations, emphasizing increased productivity, sustainability, and efficiency.

* **Bhuwan Bhaskar**

India's dairy industry has had a phenomenal run in the last many years. Over the previous nine years, milk production has grown at a compound annual growth rate (CAGR) of 5.85%. India has seen a 58% increase in volume over this time, occurring between the years 2014–15 and 2022–23. With a 24.64% share (2021–22) of the world milk output, it reached 230.58 million tons in 2022–2023, ranking the nation first globally. Together, these five states account for 53.11% of the nation's milk production: Rajasthan (15.05%), Uttar Pradesh (14.93%), Madhya Pradesh (8.6%), Gujarat (7.56%), and Andhra Pradesh (6.097%). In 2022–2023, India exported 67,572.99 MT of dairy products to the world, valued at $284.65 million.

In any race, achieving success carries the risk of complacency and looking into space. What comes next is the first question facing the Indian dairy industry. Has the industry progressed to the point where every issue facing it can be deemed resolved? Now let's investigate:

* *The author is Vice President, NCDEX, a leading agricultural commodity exchange. Email: bhaskarbhuwan@gmail.com Views expressed are personal.*

When the Indian government launched Operation Flood in 1970, it had three goals in mind: raising rural incomes, increasing milk production ("a flood of milk"), and supplying customers with affordable milk. A self-sufficient network of 43,000 village co-ops with 42,50,000 milk producers was in place by the end of 1985. All of the growth in domestic milk powder production by 1989—from 22,000 metric tons in the pre-project year to 140,000 tons—came from dairies established as part of Operation Flood. According to a study released by NABARD Research in May 2023, milk production was just 17 MT at the time of Independence in the year 1947 but it climbed to 222 MT (provisional statistics) with a compound annual growth rate of 4.9%. Thus, it is evident that Operation Flood was extremely successful in producing "a flood of milk." However, what about the following two goals?

According to data released by the Statista Research Department on May 16, 2023, India's per capita consumption of fluid cow milk in 2022 was 59.98 kg. This was more than China (11.4 kg), Brazil (49.06 kg), Russia (47.68 kg), Japan (32.79 kg), and South Korea (29.53 kg), but significantly less than Belarus (113.27 kg), New Zealand (103.18 kg), Australia (93.59 kg), the UK (89.62 kg), and the US (62 kg). When the data is combined, it becomes clear that even though India leads the world in milk production, the country still lags well behind the most affluent nations in terms of the amount of fluid milk consumed per capita. However, this is not the complete tale. From 467 million metric tons in 2013 to almost 544 million metric tons in 2022, the world produced more cow milk than ever before. The European Union is responsible for the majority of this output, producing almost 145 million metric tons of cow milk. The EU was home to approximately 20 million dairy cows that same year. But even though the EU produced the most milk, India had

over twice as many dairy cows. To put it simply, India's average yield per cow is too low when compared to other affluent countries. The average daily milk yield of exotic or crossbred cows in India was 8.52 kg in fiscal year 2022, while it was 21 kg in the EU. (Globally, the dairy sector involves 85% cows, so data related to cows only has been considered.)

In the long run, this productivity problem renders dairy unsustainable for many of the nation's farmers, among other issues. Quality-related problems arise from sustainability. Further investigation into the causes of this basic issue of "lower yield" may reveal other issues with cattle management, understanding of veterinarian health concerns, climate change and rising temperatures, and cattle nutrition. If farmers are to receive higher revenues, another factor that must be addressed is the marketing of milk and dairy products.

Farmers in other states frequently complain about not receiving a fair price for their milk, with the exception of a few where the cooperative dairy industry is quite strong. Furthermore, the majority of the impoverished cannot afford the price of milk, which is why fake and adulterated milk is booming throughout most of the nation. The state food safety laboratory of Assam has discovered that over 26% of the milk and milk product samples supplied by the unorganised sector in the city over the last three years pose major health risks to the public, according to a news item carried in The Indian Express on March 13, 2024. According to data, 497 out of 1,400 milk samples collected in Punjab in 2022–2023 were determined to be non-conforming for food safety. Of the 497 samples, 10 were deemed "unsafe" because they contained "foreign fat," as reported in an Indian Express article that was published on April 6, 2024. The fact that products of this caliber are reaching the market indicates that supply and demand are significantly out of balance, which is skewing price parity.

Therefore, India requires Operation Flood Part II, which must be driven by innovation and technology, to fulfill the two remaining goals of Operation Flood, which are raising rural income and supplying milk at a reasonable price. Dairy has to innovate urgently because of its negative impact on climate change, in addition to its high costs and decreasing viability to sustain livelihood. Few people are aware that dairy animals continuously release a significant amount of methane gas. Methane is thirty times more hazardous than carbon dioxide, and statistics show that livestock alone accounts for 18% of the greenhouse gas emissions emitted by all forms of transportation. Thus, mechanisation, automation, and innovation in the dairy industry are not only necessary for the industry's growth but are also the need of time.

The health, lifestyle, and milk quality of the animals, as well as increased profitability, are among the advantages of automation and management of dairy farms. From automated milk collection and composition testing at the village level to real-time milk procurement and evaluation of all milk quality indicators, technology has become increasingly important in the dairy business. Automation can give dairy producers information that can help them in addition to saving time, especially in regard to animal health, nutrition, and reproduction in order for all farmers to be productively balanced in their dairy production.

The dairy sector has incorporated technology and automation in the following ways:

Automated Milking Systems: The use of automated milking systems is one of the biggest developments in the management of dairy farms. The technique of milking has been radically revolutionised by robotic milking equipment. To determine when a cow is ready to be milked, attach milking equipment, and track the flow of milk, they use sensors. These devices save labor expenses and time by milking cows without the need for human involvement. Because of this technology, milk output and herd management will both grow as more cows are milked on a regular basis.

These robots come with tea cups and artificial arms. They identify each cow, find the teats, and fasten the milking apparatus using sensors and cameras. The technology calculates each cow's milk yield while it is

The dairy sector holds immense significance both globally and in India. Dairy products serve as a cornerstone of human nutrition, providing essential nutrients such as calcium, protein, and vitamins, contributing to overall health and well-being.

The history of the Indian dairy industry dates back to ancient times when the domestication of cattle and buffaloes played a crucial role in providing milk and dairy products for sustenance.

being milked. Software and sensors built into Automated Milking Systems keep an eye on a number of variables, including milk quality, frequency of milking, and cow behavior.

Data-Driven Decision-Making: Data is the foundation of the modern dairy farm. Dairy farm managers employ technology to gather and evaluate data on a range of operational elements. This involves monitoring the cattle's health and welfare. Real-time data on each cow's health is provided via wearables and sensors, which helps farmers spot and treat problems like disease outbreaks or nutritional deficits in a timely manner. Higher milk production is the result of healthier, more productive cows raised using a data-driven management strategy.

The gathering of data is the first step in the process. To get useful insights, data must be processed and analysed after it has been gathered. These choices may have an impact on a variety of topics, including risk management, resource allocation, marketing tactics, and product development.

Precision Feeding: By giving animals extremely specialised and customised nutrition technology, precision feeding is a cutting-edge approach to livestock nutrition and management that aims to optimise animal diets, especially in the context of animal agriculture. It is also transforming the way cows are fed on dairy farms. Depending on each cow's nutritional requirements, automated feeding systems may provide just the right amount of feed. This minimises feed waste while also optimising milk

output. By using automation, producers can make sure that each cow is fed a balanced diet, which will improve the herd's general health and productivity.

Sustainable Practices: Controlling dairy farming's environmental impact is becoming more and more important. More sustainable techniques are being adopted by dairy producers with the aid of technology and automation. To use less water and energy, smart barns and automated irrigation systems regulate the temperature and humidity. Furthermore, dairy farming's environmental impact can be decreased by using manure management technologies to turn waste into biogas.

Inventory and Supply Chain Management: Effective resource management is essential to the financial success of dairy farms. Feed, medicine, and other supplies are tracked using inventory management software to avoid shortages or overstocking, which can have an adverse effect on the health of the herd. Technology is also essential to the supply chain since it ensures that milk is collected, transported, and processed efficiently, cutting costs and waste.

The Future of Dairy Farm Management: The management of dairy farms appears to have much greater promise going forward. Artificial intelligence and robotics are being incorporated into the industry more and more. These technologies can be applied to various jobs, such as sorting cows, cleaning barns, and even feeding and disposing of rubbish with autonomous trucks. AI is also being used to anticipate health problems and behavior in cows, allowing for proactive management and care.

Digitalisation: It might be viewed as the dairy industry's next crucial step toward increasing efficiency as well as resolving existing issues. Digitalisation has the potential to be extremely important in a number of fields, including AI-driven predictive analysis, robotic milking, livestock management, and more. While some of these sectors have already begun to undergo digitalisation, others are ones that we anticipate growing in the years to come.

Cognitive Health & Dairy: Concerns regarding the population's deteriorating cognitive health have increased since the pandemic's start. People who struggle to strike a healthy work-life balance, such as homemakers, health professionals, students under stress from their studies, and others, are increasingly turning to functional meals as a way to unwind and relieve tension from their daily lives. Dairy businesses are always coming up with new ideas in this field.

The 'White Revolution', a term to describe the rapid growth of the dairy industry in India, was fuelled by 'Operation Flood'. This period witnessed significant increase in milk production, dairy cooperatives, and milk processing facilities.

Dairy-based Sports and Nutrition: Sports drinks are specially designed liquids meant for athletes that help them stay hydrated and provide them with more energy than water. Conventional sports drinks are laden with sugar and artificial additives. Consumers now favor healthier foods with less sugar due to growing health concerns. And milk fits in here somewhere. It contains all the essential nutrients for an athlete, including calcium, vitamin D, carbs, and electrolytes. Additionally, it has two proteins that aid in muscle growth: whey and casein. It's not a novel idea to drink milk to rehydrate after working out. But as consumers' attention has turned more toward health, this field has grown up and is witnessing some intriguing advances.

Reducing Greenhouse Gas Emissions: Food derived from animals, including feed for livestock, accounts for 57% of greenhouse gas emissions produced by the food industry. It's interesting to note that it is double that of plant-based diets. The food business is responsible for 35% of greenhouse gas emissions worldwide. The dairy industry has begun to work toward lowering ruminant methane emissions as one of its priorities. To address this, they are experimenting in a number of ways, such as developing novel ways to create sustainable feed and forming alliances with businesses that can assist them in capturing methane.

Infant Nutrition: There is a need for nutrition products as a result of increased awareness of children's health and the significance of an infant's first 1000 days of nutrition. Dairy companies therefore continuously innovate in the baby formula market to get attention and, in one way or another, capture consumer sentiment.

Recent Technology Upgradation in the Dairy Farm Sector

Globally, there have been notable advances in technology in recent years. Modern technology has brought about a dramatic change in the dairy farm industry in recent years. These developments have completely changed the way dairy farms run their operations, emphasizing increased productivity, sustainability, and efficiency.

The use of automated milking systems, the Internet of Things and sensor integration for data-driven decision-making, and the application of AI and machine learning for improved farm management are some of the major advancements.

Benefits of Technology and Automation in the Dairy Industry

A dairy farm needs to make sure that everything it does is done in a way that promotes the health and comfort of the animals. Farm management systems can help monetize all of the farm's potential livestock by digitising output and operations. The first stages in empowering farmers are electricity access, a digital revolution, and smartphones that provide market access and high-quality services. Farmers can also become aware of the superior technologies available to them for managing dairy farms and keeping an eye on their animals.

With the use of technology, farmers can now easily monitor enormous herd sizes and save money, time, and energy by utilising an app-based system that runs simultaneously on many mobile phones. These technologies are handy and alert for a specific activity required at the farm/cow level, and they can record the herd, cow performance, the breeding cycle, the lactation cycle, and the vaccination schedule. They can also provide information about the animal's udder health.

The complete activities of a dairy farm will be automated and digitalised by these systems, saving money, energy, and time. To have a revolutionary impact on the dairy farming sector, farms must embrace automation and these new technologies.

Conclusion

The way dairy farms are managed has undergone a radical change because of technology and automation. Dairy farming is becoming more efficient, economical, and sustainable thanks to advances like automated milking systems, data-driven decision-making, precision feeding, and sustainable practices.

Every aspect of dairy farm management has been enhanced by technological improvements, from precision feeding that maximises animal nutrition to data-driven decision-making that empowers informed choices and automated milking systems that improve efficiency and cow well-being.

It is obvious that technology will have a significant impact on how dairy farm management develops in the future as the sector continues to change. Accepting these innovations benefits consumers as well as dairy producers since it allows them to purchase sustainable, high-quality dairy products. ❑

Rural India: Innovation for Inclusiveness

Inclusiveness is fundamental to development principles. It is indisputable that the availability of facility or resource alone will not ease the life of the under privileged or the marginalised, unless they are provided with seamless access. Innovative ideas in development sectors have tremendously contributed in bringing down the gap in the equitable distribution of development potential between urban and rural populations. The article discusses the impact of innovation in nurturing inclusiveness in Indian rural sector.

*** Arunlal K**

According to the United Nations, innovation for development means using the most up-to-date concepts, tools, and is about finding better ways to create impact on people and the planet, to strengthen resilience and build more inclusive societies. India has been consistently improving its position in Global Innovation Index (GII), published by World Intellectual Property Organization (WIPO), from 48 in 2020 to 40 in 2023. In GII 2023, our country is the first among 37 lower-middle-income economies in Central and Southern Asia. Between 2001 and 2020, the number of scientific and technological capabilities that India is specialised in jumped from 42% to 68%, and from 9% to 21% respectively. Innovation has always been the key pillar for progress. Government of India's policies for the past few decades reinforced the innovation drive with inclusive development as central theme. For example, the number of telephone connections surged from 41 million to 943 million during 2001-2012, out of which 911 million alone were mobile phone. The increasing tele-density (number of phone connections per 100 people) and sharply declining tariffs in a competitive market made India the fastest-growing telecommunications market in the world and placed it far ahead of its peers in the Central and Southern Asian regions. Rural tele-density has grown over 30 times from 1.7% in 2004 to 58.5% in 2023. Further, the urban-to-rural tele-density ratio has reduced from 12.24 to 2.29 during this period. The Prime Minister Wi-Fi Access Network Interface (PM-WANI) scheme envisages provision of Broadband through public Wi-Fi Hotspot providers and also helps to increase internet penetration in rural areas. It is interesting to observe how these achievements reflect in the lives of rural population by nurturing inclusiveness.

The author is an experienced professional in policy formulation, water resources management, operation of major and medium irrigation projects, and basin level planning. Presently working as Engineer in Irrigation Department, Govt. of Kerala. Email: arunlal.tkm@gmail.com

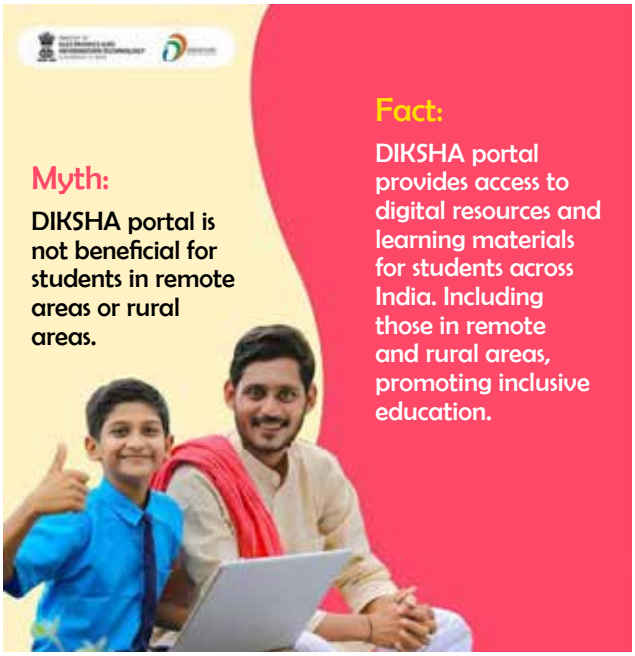
Healthcare

One of the major concerns of rural population is their access to quality healthcare facilities. Most of the highly qualified healthcare professionals tend to choose to work in urban areas. Villagers often find secondary-level healthcare either inaccessible or unaffordable. The digital innovations have played a major role in addressing this issue effectively to a great extent. e-Sanjeevani – the national telemedicine service- was a landmark in India's e-health initiatives and a game changer in the rural health sector. The number of consultations crossed 100 million in about 3 years since its launch in November 2019 and now stands at 241 million consultations. It is important to note that over 57% of the beneficiaries of e-Sanjeevani are women and around 12% of beneficiaries are senior citizens. This has brought the expert health advice to the rural population who could not afford to travel to the cities for secondary health care needs. Digital Health Innovations Group at Centre for Development of Advanced Computing (C-DAC), Mohali (India) is the implementing agency for e-Sanjeevani. Since 2018, the group has been working with the Ministry of Health and Family Welfare (MoHFW), Government of India to conceptualise a population-scale telemedicine application. Accordingly, e-Sanjeevani was customised to be implemented at more than 1,55,000 Ayushman Arogya Mandir (AAM) across India in Hub-Spokes model. Patients who walk into Health and Wellness Centres (HWCs), community health officers in Health & Wellness Centres facilitate the teleconsultation with the doctors and specialists in hubs established in secondary/tertiary level health facilities or medical colleges.

Education

The urban–rural disparity in education has a long-lasting and fathoming impacts in worsening the social inequality. The children of urban dwellers have the advantage of choosing the best among better options both in case of schools and for extra-curricular trainings. This inequality is reflective in the results of most of the post-secondary competitive exams. Increased penetration of internet and the boom in education apps have helped the rural children to gain opportunities as good as their urban counterparts. Online classes during the pandemic period were a major catalyst to adopt digital learning in rural India. Now, the rural children have access to all world-class resources in a single click. Decline in the cost of data and the availability of lower-cost digital device have reinforced the trend of harnessing the power of digital education.

Further, integration of Artificial Intelligence (AI) has created an environment for customised learning. Mobile apps, internet-based courses, and interactive educational platforms empowered by AI algorithms are providing high-quality learning materials conveniently accessible to both students and educators. The



expansive capabilities of AI technology render it cost-efficient, alleviating the financial strain typically linked with conventional teaching approaches.

Banking and Finance

Getting credit or accessing the banking services were not easy for the rural population in general, and for the underprivileged in particular. This hurdle has started alleviating with the advent of Aadhar-based banking. One of the key ways Aadhaar has facilitated bank credit in rural India is by streamlining the Know Your Customer (KYC) process. Aadhaar's extensive database and biometric authentication capabilities have enabled banks and financial institutions to improve credit scoring and risk assessment processes, particularly for underserved populations in rural India. By leveraging Aadhaar-linked data, lenders can better evaluate the creditworthiness of borrowers, mitigate risks, and offer tailored financial products suited to the needs of rural customers. Under initiatives such as the Credit Linked Subsidy Scheme (CLSS), Aadhaar authentication has been instrumental in providing housing finance to rural beneficiaries.

Innovative digital payment solutions are reshaping how transactions are conducted in rural areas. With the rise of mobile wallets, QR code payments, and USSD-based services, rural residents can now make purchases, pay bills, and transfer money digitally without the need for physical cash. These solutions offer security, convenience, and efficiency, driving financial inclusion and fostering economic growth in rural regions. Further, agent banking has emerged as a game-changer in rural areas where establishing brick-and-mortar bank branches is often economically unfeasible. Through agent banking, financial institutions leverage local businesses or individuals as agents to provide basic banking services in rural communities. This model extends banking services to remote areas, allowing villagers to deposit, withdraw cash, and perform other banking transactions conveniently within their own neighborhoods.

Agriculture

About 70% of the rural households depend on agriculture for livelihood. Raising agriculture productivity and ensuring market linkage have always been stumbling blocks in improving the lives of farmers. Climate change, pest attacks, lack of easy access to insurance schemes, and deficit of market information often exacerbate the income disparity of rural farmers, and leads to poverty. Technological advancements and innovative approaches pave way for a paradigm shift to make agriculture profitable and a reliable source of income.

The advent of drones is one such example. Drones are being used in precision spraying of fertilisers and pesticides, field-level monitoring of crops, planting of crops, soil property assessment, crop health monitoring, etc. This has helped to improve farming efficiency by reducing time and labour, and by improving precision. AI-enabled drones can detect the moisture content, and thus helps to improve irrigation efficiency as well. The Government of India is providing financial assistance for procurement of drones. 50% of the cost of drone, up to a maximum of Rs. 5.00 lakhs, is provided for Small and Marginal, Scheduled Caste/Scheduled Tribe, Women, and North Eastern State farmers, whereas other farmers are given 40% of the cost up to a maximum of Rs. 4.00 lakhs. The Government has also conceptualised

a Central Sector Scheme for providing drones to the Women Self Help Groups (SHGs) with an outlay of Rs. 1261 Crores. The scheme aims to provide drones to 15000 selected Women SHGs for providing rental services to farmers for agriculture purpose (application of fertilisers and pesticides).

Digitisation of farm insurance helped in speedy resolution of claims. The mobile apps linked with crop insurance help the farmers not only to find out complete details about insurance cover available in their area but also to calculate the insurance premium for notified crops, coverage amount, and loan amount in case of a loaned farmer. Farmers can report crop loss through the apps or through Krishi Rakshak Portal helpline. Weather Information Network and Data System (WINDS) is launched to augment the weather data collection system in the country in terms of adequacy of network, data collection, data standardisation, data hosting, and dissemination through coordinated efforts with India Meteorological Department (IMD) and States, to support the crop insurance requirements. Kisan Call Centre and many apps are in place which are specially designed to provide information about fertilisers, subsidies, new varieties of plants, pesticides, current weather, forecasts for the coming days, and market prices of commodities in nearby Mandis. Krishakti, Kisan Suvidha, Soil Saathi, Krishi Mitra, mKrishi, Sanchar Shakti, Pusa Krishi, and Shetkari are a few examples.

Access to Clean Water

According to the World Health Organization (WHO), access to safe drinking water is when at least 20 liters of water per person per day is available from an improved source within one kilometer of a person's home. As per the National Family Health Survey – 5 (2019-21) the population living in households with an improved drinking-water source in urban areas is 98.7% while that in rural areas is 94.6%. This disparity further impacts in rural health standards, social security, children's educational opportunities, and earning capability. Startups working on technological innovation have been trying to bridge this gap through various interventions. Boon (formerly known as Swajal), a water-tech startup is striving to make water accessible and affordable by ensuring reliable supply of safe drinking water. Their proprietary water ATMs are energy-efficient systems that use solar energy for water purification and vending, with easy-to-use user interfaces and payment mechanisms. IoT-based remote monitoring capabilities built into the cloud platforms makes repairs and upgrades seamless. They have installed over 400 Water ATMs in railway stations, schools, hospitals, urban slums, rural areas, and bus stations. The startup has currently impacted over 20 lakh people across more than 140 Indian villages by democratising access to clean drinking water.

Excessive use of groundwater and lack of information about the depth of groundwater table are challenging in rural water management where a vast majority is dependent on groundwater. Bhujal app, the first of its kind Android app, made the process simpler by making it possible to measure the water level within a minute without even opening the borewell. This helps any user, particularly the rural farmers to get an idea about water availability and facilitate better planning. This avoids early drying of a borewell and thus proves to be a powerful decision-making tool in the demand side. It also helps to save electricity due to the regulated consumption of borewell water.

Kheyti is a startup working to address water scarcity issues for small farmers. Kheyti's Greenhouse-in-a-Box helps them reduce climate risk and increase yields. According to the founders, the plants in the greenhouse require 90 percent less water than those outdoors and yields are seven-times higher. Being ninety percent cheaper than a standard greenhouse, they are contributing to increase farm incomes, helping them invest more in their farms and other social needs like healthcare and education of children. It also contributes to sustainable agriculture practices by using less water and fewer pesticides. Water being a scarce commodity in large parts of rural India, 90% water savings on agriculture is a vital step in ensuring rural water security.

Conclusion

Innovation in rural India has contributed significantly towards the sustainable development goals (SDGs) and is well aligned with the Prime Minister's vision of *Collective Efforts, and Inclusive Growth.* However, since most of the life-easing innovations are mounted on digital platforms, robust digital infrastructure is essential to sustain the growth and development in rural India. It is also vital to be cautious about the urban bias among large firms which could be detrimental to the idea of rural inclusiveness. ❑