

MAKING LAKHPATI DIDIS: MULTIPLE LIVELIHOODS SHOW THE WAY

Deendayal Antyodaya Yojana-National Rural Livelihoods Mission (DAY-NRLM) is a major poverty eradication program by India's Ministry of Rural Development. It has mobilized over 10 crore households into 91 lakh Self-Help Groups (SHGs). These groups receive capital support for inter-lending and connections to formal financial institutions. With SHG mobilization and financial inclusion saturated, focus has shifted to sustainable livelihoods. The Lakhpatti Didis initiative aims for each household to earn ₹1 lakh annually, supported by Integrated Farming Clusters. An Integrated Farming Cluster (IFC) consists of 2-3 adjoining villages, covering 250-300 households. It supports diverse livelihoods (farm and non-farm) with strong linkages, focusing on the poorest. The strategy includes asset creation, skilling, affordable credit, and improved market and technology access.

Strategy

- The IFC targets areas with saturated social mobilization and financial inclusion, ensuring households have consistent, profitable income sources year-round, protecting farmers from monsoon and market price fluctuations.
- 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.
- The IFC clusters aggregate individual produce through Producers' Groups (PGs) at village or cluster levels, reducing transaction costs. In larger areas, PGs federate into Producers Enterprises for processing, packaging, and direct or partnered market linkages.
- 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 IFCs, women farmers are central, participating as both farmers and entrepreneurs. The project ensures their active involvement but requires societal mindset changes and increased awareness for greater 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 IFC 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:** Identifying an IFC's geographical contour is crucial for accessibility, common commodities, and social structure. Areas with significant livelihood asset creation potential through MGNREGS and Ministry of Agriculture convergence are preferred.
- **Identification of Households:** Beneficiaries from existing SHGs involved in mission-sponsored farm activities join IFC clusters. Women farmers must focus on agriculture or livestock, participate in Farmer Field Schools, and be part of producer groups or companies.
- **Commodity Identification:** A study in the selected cluster assesses farmers' situations and agriculture levels, identifying potential products for the IFC cluster. It targets 2-3 commodities, universal or easily adopted, with good market potential, ensuring all households can adapt and benefit.

- **Placement of Human Resource:** The guidelines require two dedicated human resources: an IFC anchor and a Senior Community Resource Person (CRP). They must be identified, trained, and deployed for smooth project implementation. The IFC anchor ideally holds a degree/diploma in agriculture or allied sciences with at least one year's experience in promoting farm-based livelihoods, preferably in extension and marketing. Alternatively, a candidate with a regular Bachelor's degree and two years' relevant agricultural experience may be considered. The Senior CRP may come from experienced Krishi Sakhi, Pashu Sakhi, Van Sakhi, or Udyog Sakhi under DAY-NRLM, active for over two years, demonstrating entrepreneurial skills and completing approved CRP training modules by NMMU.
- **Baseline Survey:** An initial socioeconomic survey of the cluster assesses various factors to plan interventions and business development. Using stratified random sampling, it includes household interviews and stakeholder discussions to establish baseline figures and outcome indicators for future measurement of change contributions.
- **Development of Training & Capacity Architecture:** Each Integrated Farming Cluster is unique in geography, climate, social norms, and commodities. Tailored training materials for CRPs, women farmers, and staff are essential, leveraging support from Krishi Vikas Kendras/RCRC partners as needed.
- **Business Plan for Commodity Wise Intervention:** Business planning in IFC is crucial. Once 2-3 commodities are identified for a cluster of 250-300 households, plans must detail production, processing, and marketing strategies. Baseline assessments and collective marketing visualization guide comprehensive business plans with projections.
- **Livelihood Service Centre:** This Centre serves as a hub for input, processing, and output services overseen by the Senior CRP. In agricultural areas, private players provide essential services like inputs, machinery, and livestock care, critical for cluster development. Livelihood Service Centres are established at cluster levels to provide these services at affordable rates, managed by the anchor, Senior CRP, and block mission unit.
Farmers face challenges in selling produce due to distant markets, increasing costs and time. Livelihood centers are crucial for procuring, sorting, grading, bulk selling, and linking with markets, leveraging Farmer Producer Organizations and private entrepreneurs.

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: The Livelihood Resource Centre has Primary and Secondary Processing components, contingent on commodity-specific business plans, community needs, and processing unit capacity utilization. Strategic decisions, like third-party oil extraction, require resolution at 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):** The IFC project should collaborate with existing FPCs. Promote backward and forward linkages with producer groups. Enroll farmers in the IFC, where PG members participate in livelihood planning sessions to identify household economic activities and address issues with project support.

Financing

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

Project Implementation

- Initially conceptualized in 13 states under the World Bank-funded NRETP (Assam, Bihar, Chhattisgarh, Jharkhand, Gujarat, Rajasthan, Madhya Pradesh, Maharashtra, Karnataka, Odisha, Tamil Nadu, Uttar Pradesh, and West Bengal), 400 clusters were sanctioned. Building on their success and strategy, 6,000 more clusters are approved under the Mahila Kisan Sashaktikaran Pariyojana, a sub-component of DAY-NRLM.

Success Story

- In Kondagaon block, Chhattisgarh, an IFC cluster improved economic outcomes for 250 households across four villages. Interventions in maize, vegetables, non-timber forest produce, and poultry raised monthly incomes from Rs 1,000 to Rs 12,000 per member, significantly enhancing food sufficiency and supporting the Lakhpati Didi Initiative.

Conclusion

- Integrated Farming Cluster, a new concept by DAY-NRLM, offers sustainable livelihoods to rural SHG households. With strategic planning and market focus, it fosters community confidence and entrepreneurial spirit, potentially transforming women farmers' incomes beyond Lakhpati Didi's vision.

JUGAAD INNOVATIONS: TRANSFORMING RURAL INDIA

In India's rural heartland, a silent revolution driven by "jugaad" is empowering communities with frugal, ingenious solutions, addressing challenges and bridging the socio-economic divide. Jugaad innovations provide affordable solutions in agriculture, healthcare, education, and energy, showcasing rural India's resilience and creativity. They promise a future where rural India leads in progress. In rural India, jugaad innovations empower communities to address local challenges with minimal resources. Farmers create cost-effective tools, while artisans craft sustainable alternatives, enhancing productivity and preserving cultural heritage. Local entrepreneurs repurpose waste into useful products, like plastic bottle drip irrigation systems. The National Innovation Foundation supports these resilient grassroots innovations, enhancing livelihoods and sustainable development across rural India.

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, Yamuna Nagar, is a 10th-grade pass from a small farmer family. Despite financial hardships, he understood machines early, making heaters and machines for villagers. Moving to Delhi with just 70 rupees, he spent half on fare and the rest on food, eventually driving a rickshaw and sleeping on footpaths and platforms due to a lack of shelter. While returning to his village and starting organic farming, Dharambir Kamboj could not afford expensive fertilizers and used cow dung manure. Inspired by a Krishi Vigyan Kendra training on making rose water, he built his own multi-purpose food processing machine. After months of effort, his machine could process various fruits and medicinal crops, producing products like gel, juice, and extracts. After making his machine, Dharambir began processing his crops and selling products directly to the market. Other farmers requested machines, catching the attention of the National Innovation Foundation and Honeybee Network. They found the machine could make farmers self-reliant. Dharambir received a patent, and his machine is now exported to Japan, South Africa, Kenya, Nepal, and Nigeria. He has travelled abroad multiple times to train farmers in crop processing. 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 crores 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**

Mansukh Bhai 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. Mansukh Bhai Prajapati revived clay products with innovative, eco-friendly items like refrigerators, filters, tawas, and cookers. Despite his family's hardships and migration after the Machhu dam breakdown, he reconnected people with clay, revolutionizing its use in daily life. Mansukh Bhai joined a pottery firm in 1985, learned the trade, and started an earthen plate factory using a tile press. He borrowed Rs. 30,000, set up a workshop, and secured a significant order for innovative terracotta water filters. Inspired by the 2001 Gujarat earthquake, Mansukh Bhai developed the MittiCool clay refrigerator, using sawdust and sand to keep it cool. He also creates clay water filters, pressure cookers, and non-stick tawas. Dr. APJ Abdul Kalam called him a "true scientist." From selling handmade clay pots and pans in villages on an old bicycle to building a Rs.3 crore turnover company - MittiCool Private Limited - Mansukh Bhai has come a long way.

- **Amphibious Bicycle that Floats on Water**

During the 1975 flood in East Champaran, Bihar, Mohammad Saidullah invented a water-propelled bicycle in three days to navigate the floodwaters after a sailor refused him passage without payment. He adapted a conventional bicycle with four rectangular air floats for water movement. These floats attach to the wheels and can fold for land use, allowing seamless transition between water and land. He also designed a pedal-powered water-propelled rickshaw. The amphibious bicycle offers rural communities independence from crowded boats for river crossings, saving time and money by operating on both land and water. Saidullah, renowned for inventions like hand-operated pumps, fans, mini tractors, and battery-operated bicycles, received the Grassroot Innovation Award from Dr. APJ Abdul Kalam in 2005. He was also recognized by the Wall Street Journal Asian Innovation Awards. His innovations earned global attention until his passing in December 2023.

- **Bicycle Weeder - Krishiraja**

Gopal Malhari Bhise of Jalgaon, Maharashtra, lived 4 km from his farm and used a bicycle to commute. Inspired by a person carrying four sacks of flour on a bicycle, he transformed it into 'Krishiraja', a farming machine for weeding and ploughing fields. The bicycle weeder, made from bicycle parts, includes the handlebar, front axle, and wheel. It features a steel fork with interchangeable weeding and tilling attachments, adjustable blade distances, and optimized soil digging efficiency. Beneficial for farmers without bullocks or tractors, suited for smaller land holdings where such equipment is not necessary. After much experimentation, Gopal developed 'Krishiraja' from bicycle parts—a portable implement for marginal farmers to replace bullocks or tractors. It's popular locally, with 213 units made, each priced around Rs.1200. 'Krishiraja' empowers marginal farmers, turning them into agricultural leaders.

- **Chandraprabha Water Gun or Rain Gun, a sprinkler**

Annasaheb Udagavi from Sadala village, Belgaum district, North Karnataka, invented the Chandraprabha Water Gun, a sprinkler that eliminates white flies and aphids from tobacco plants and irrigates sugarcane effectively. Believing in washing down aphids and white flies with high-pressure water, he turned to sugarcane for better returns. Facing salinity issues with well irrigation, he developed the Chandraprabha Water Gun sprinkler system for effective crop irrigation. The Chandraprabha Water Gun, a sprinkler with a 140 feet radius, irrigates sugarcane. Years ago, before drip irrigation was widely known, he used PVC pipes with perforations made using nails to save his two-acre betel-vine orchard from water scarcity, maintaining it for seven years with daily one-hour irrigation costing Rs. 30,000. Current irrigation methods consume excessive water, challenging in semi-arid and arid regions with low water availability. Drip and sprinkler systems, though efficient, struggle with long and dense crops. The

Chandraprabha Rain Gun innovatively uses separately geared nozzle assemblies for surface irrigation, designed by self-taught Annasaheb Udagavi, ideal for sugarcane cultivation.

- **Bullet Santi Multipurpose Motorcycle Operated Farming Equipment**

Due to high tractor costs and expensive bullock fodder, along with frequent droughts and labor shortages, Mansukhbhai Ambabhai Jagani of Saurashtra, Gujarat, sought an alternative to bullocks for his small landholding.

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.

Mansukhbhai retrofitted a motorcycle chassis and drive to support various farm implements. Removing the rear wheel, he attached a tool bar for flexibility. This innovation can adapt to vehicles like the Chhakdo rickshaw with at least a 6.5 HP engine.

The Bullet Santi fulfils tasks like ploughing, weeding, seeding, and spraying, enhancing productivity and cutting operational expenses for farmers unable to afford tractors or power tillers relying on bullocks for ploughing.

The Bullet Santi, patented in India and the US, revolutionizes farming for hundreds of Indian farmers. Cost-effective and efficient, it ploughs one acre in under half an hour using two liters of diesel, de-weeding at Rs.8 per hectare. After fieldwork, it converts into a bike for travel in half an hour, costing around Rs.38,000

Jugaad innovations are transforming rural India, driving economic growth, improving livelihoods, and fostering sustainable development. These grassroots solutions harness local ingenuity to address unique challenges, empowering communities and paving the way for inclusive progress in resource-constrained environments.

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 INNOVATION IN RURAL INDIA

India, home to over 1.4 billion people, is experiencing significant rural transformation. Despite economic growth, rural areas, characterized by agriculture, face developmental challenges and opportunities for innovation.

The Current Landscape

- Rural India's poverty rate dropped from 32.59% in 2015-16 to 19.28% in 2019-21, thanks to government initiatives like MGNREGA, PMAY-G, and the Saubhagya Scheme for electrification.
- Despite advancements, rural areas face challenges like inadequate infrastructure, limited healthcare access, and educational disparities. Malnutrition affects 35.5% of children under five. Unemployment was 2.4% in 2022-23, needing better job opportunities.
- These challenges present opportunities for innovation. Digital technology, renewable energy, and advanced agriculture are transforming rural economies. With 751.5 million internet users and 462 million YouTube users, connectivity boosts education, healthcare, and economic activities.

Government Initiatives and Innovations

- The Indian government fosters rural innovation through initiatives like PMUY, providing clean cooking fuel, and the Swachh Bharat Mission, improving sanitation and declaring over 100,000 villages Open Defecation Free (ODF).

- In agriculture, innovations like precision farming, drones for crop monitoring, and genetically modified crops boost productivity and incomes, with drones in Punjab increasing yield by 20% and reducing pesticides by 30%.
- Renewable energy projects, like solar microgrids in Rajasthan and Bihar, provide reliable electricity to remote villages, fostering economic activities and improving quality of life.

A Vision for the Future

- Public-private partnerships drive rural innovation. Collaborations among government, private companies, and NGOs create sustainable development. The E-Choupal initiative by ITC Limited revolutionizes agriculture by providing farmers real-time market information, boosting their bargaining power and income.
- The vision for rural India focuses on continuous innovation and inclusive growth, aiming to create a resilient economy leveraging modern technology while enhancing infrastructure, healthcare, education, and fostering entrepreneurship.
- Despite challenges, rural India's progress and innovation potential are undeniable. Strategic initiatives, technological advancements, and the people's spirit drive equitable growth. The focus remains on inclusive, sustainable development, ensuring benefits reach all corners 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 revolutionizes agriculture by using GPS, IoT, and AI to optimize inputs like water and fertilizers. For example, soil sensors in Maharashtra increased crop yields by 20% and cut water usage by 30%.

Drones: The New Eyes in the Sky

- Drones are now widely used in agriculture for crop monitoring, pesticide spraying, and soil analysis. The Indian government's Kisan Drone initiative aims to make this technology accessible to small farmers.

Digital Platforms: Bridging the Information Gap

- Digital platforms like eNAM create a unified national market for agricultural commodities, connecting farmers directly with buyers across India to improve prices and reduce middlemen.

Sustainable Practices: The Push for Eco-Friendly Farming

- Modern agricultural innovations prioritize sustainability through techniques like organic farming, agroforestry, and biofertilizers.

Farmer Producer Organizations (FPOs): Strength in Numbers

- FPOs are revolutionizing agriculture by aggregating small farmers, boosting their bargaining power, and improving access to inputs, credit, and markets.

Renewable Energy: Powering the Future of Farming

- Renewable energy solutions like solar pumps and microgrids meet rural farms' energy needs sustainably. In Gujarat, the Suryashakti Kisan Yojana (SKY) allows farmers to generate electricity with solar panels, reducing reliance on grid power and lowering bills.

Innovative Startups: Catalysts for Change

- Agritech startups like DeHaat and AgroStar bring advanced technology to rural farms through digital platforms offering inputs, advisory services, and market linkages with AI and big data analytics. Technology and innovative agricultural practices are paving the way for a productive, sustainable, and profitable future in rural India, enhancing livelihoods and sector resilience with immense transformative potential.

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

- Decentralized renewable energy (DRE) technologies like solar pumps, dryers, and micro-grids are creating sustainable livelihoods in rural India by reducing post-harvest losses and increasing income, as exemplified by Shivraj Singh Chouhan's success in Uttar Pradesh.
- DRE technologies can impact 37 million livelihoods, generating about USD 50 billion in revenue, supported by government policies and financial incentives.

Water Management Initiatives

- Effective water management is crucial for sustainable livelihoods in rural India. Initiatives like the Jeevika program promote women's involvement in water and sanitation projects. In climate-vulnerable regions, leveraging local community expertise, as seen in Maharashtra's "One Stop Shop," trains youth as WASH Mitras to maintain water infrastructure, providing essential services and generating employment.

Promoting Green Jobs

- The Council on Energy, Environment, and Water (CEEW) promotes green jobs and sustainable livelihoods by focusing on the economic potential of clean energy, bioeconomy, circular economy, and nature-based solutions.

Rural Technologies

- Technological innovations are pivotal in enhancing sustainable livelihoods in rural areas, bridging the urban-rural technology gap. Examples include efficient cereal threshers and harvesters, artificial glaciers in Leh-Ladakh, and solar-powered devices, boosting productivity and supporting small entrepreneurs and self-help groups (SHGs).

Empowering Rural Women

- Empowering women through sustainable livelihood initiatives is crucial for holistic rural development. Programs focusing on skill development and entrepreneurship among rural women yield economic and social benefits, such as improved service delivery and increased household incomes.
- In conclusion, the integration of renewable energy, water management, technological innovations, and women's empowerment significantly enhances sustainable livelihoods in rural India. These initiatives create diverse income opportunities, foster sustainable development, and improve overall quality of life in rural communities. Continued support and expansion of these approaches can lead to inclusive and sustainable growth across India's 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 revolutionized rural India through initiatives like PM-KUSUM, installing solar pumps and grid-connected plants to reduce dependence on conventional power and ensure sustainable irrigation.
- Solar energy projects in states like Rajasthan, with a renewable capacity of 17,040 MW, utilize vast arid lands for solar farms. They supply power to rural homes and enhance agricultural productivity and sustainability.

Wind Energy: Harnessing Natural Power

- Wind energy is crucial in India's renewable strategy, with states like Tamil Nadu and Gujarat leading in harnessing wind power. India aims for 30 GW of offshore wind capacity by 2030 to meet its energy demands.
- The Wind-Solar Hybrid Policy promotes combining wind and solar power to maximize transmission infrastructure and land use, ensuring a stable energy supply to rural areas and addressing intermittency issues of renewable sources.

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

- Decentralized renewable energy solutions like mini-grids and solar home systems are vital for remote rural areas. MNRE promotes these solutions, enhancing village life and supporting economic activities by providing reliable electricity off the national grid.

- In Andhra Pradesh, decentralised solar dryers revolutionize agricultural processing by extending produce shelf life and cutting post-harvest losses, ensuring better prices for farmers, and promoting environmental sustainability by reducing diesel generator reliance.

Innovative Applications: Expanding the Horizons

- Renewable energy in rural India goes beyond electricity. Solar cold storage preserves produce, cuts wastage, and secures market prices. Solar pumps in Bihar boost crop yields with reliable water supply.
- The National Green Hydrogen Mission aims to produce 5 million tonnes of green hydrogen annually by 2030, revolutionizing rural industries with clean energy for transportation and manufacturing, creating economic opportunities and cutting carbon emissions.

Policy Support and Future Prospects

- The Indian government supports renewable energy through policies like the PLI scheme for solar PV and the National Hydrogen Mission, aiming for 500 GW capacity by 2030, expected to boost rural economies with employment opportunities.
- Renewable energy transforms rural India, fostering sustainability and resilience. Solar, wind, and other technologies enhance energy independence, boost agricultural productivity, and improve quality of life, advancing towards a greener and more prosperous future.

Policy and Institutional Support: Catalysing Innovation

- Rapid renewable energy advancement in rural India relies on strong policy frameworks and institutional support, catalysing innovation, and sustainable development. Government initiatives aim to enhance energy security, cut carbon emissions, and promote economic growth.
- The MNRE promotes renewable energy through schemes like the Renewable Purchase Obligation (RPO), mandating a percentage of energy from renewables, with targets reaching 43.33% by 2030, ensuring steady demand and sector investment.
- The PM-KUSUM scheme aims to provide solar-powered irrigation pumps to farmers, reducing reliance on grid electricity and diesel. This promotes clean energy and lowers operational costs, boosting farmers' income.

Financial Support and Incentives

- Financial support is crucial for promoting renewable energy. IREDA plays a significant role by providing financial assistance for projects. Awarded 'Infrastructure Finance Company' status by the RBI in 2023, IREDA's successful IPO in late 2023, oversubscribed by 38.8 times, reflects strong investor confidence in the sector.
- The government introduced the Production Linked Incentive (PLI) scheme for high-efficiency solar PV modules to boost domestic manufacturing, reduce import dependency, and foster renewable energy industry growth in India.

Institutional Support and Capacity Building

- Institutional support is crucial for renewable energy projects. MNRE has established autonomous institutions like NISE and SECI to support research, development, and deployment of renewable energy technologies.
- Capacity building is crucial, with the government partnering with ITIs to create a skilled workforce for green jobs. Training programs and technical assistance ensure communities can manage renewable energy installations, promoting sustainability and rural employment.

International Collaboration and Leadership

- India's global renewable energy leadership is evident through its IRENA Presidency in 2023 and its focus on energy security, accessibility, and sustainability during its G20 Presidency, advancing global renewable energy goals.

Prospects and Challenges

- While progress has been notable, challenges persist in rural renewable energy adoption. MNRE's framework aims to tackle these with financial support, research promotion, and standardized testing protocols for DRE technologies.
- In conclusion, India's government efforts, backed by strong policies, incentives, and institutions, are transforming rural areas through renewable energy. Building on these foundations will help achieve ambitious targets for sustainable, inclusive rural growth.

Challenges and Opportunities: Navigating the Path Forward

India faces challenges and opportunities in its renewable energy push, especially in rural areas. Overcoming technological, financial, and infrastructural hurdles can pave the way for growth and innovation in sustainable energy solutions.

Challenges

Grid Integration and Flexibility: Integrating variable renewable energy (VRE) like solar and wind into the power grid poses challenges, especially in states rich in renewables such as Karnataka, Tamil Nadu, and Gujarat. Grid stability issues due to variability require advanced management and flexibility solutions as India aims for 450 GW of renewable capacity by 2030.

Financial Barriers: Financing is a critical barrier to widespread adoption of renewable energy in rural areas. Despite declining technology costs, high initial capital investments remain a challenge. Initiatives like the PLI scheme and efforts by IREDA provide some relief, but more accessible and affordable financing solutions are needed.

Technological and Infrastructure Gaps: Rural areas often lack infrastructure to support advanced renewable energy systems. Deploying decentralised renewable energy (DRE) solutions like mini-grids is hindered by inadequate local infrastructure and the need for standardized, high-quality technology.

Policy and Regulatory Hurdles: While there are policies supporting renewable energy, inconsistencies and regulatory hurdles can impede progress. For instance, Renewable Purchase Obligations (RPOs) mandate increasing renewable energy percentages but need clearer implementation guidelines and enforcement mechanisms across states.

Opportunities

Advancements in Energy Storage: Energy storage technologies, especially battery storage, are advancing rapidly and becoming more cost-effective. Integrating battery storage can mitigate renewable source variability, ensuring stable and reliable power supply. India aims for up to 200 GW of battery storage capacity by 2040, potentially becoming a global leader in this field.

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 offers India a chance to diversify its energy mix. Produced from renewable sources, it can power sectors like transportation and industry. The National Hydrogen Mission aims to position India as a global green hydrogen hub, fostering innovation and investment in this burgeoning sector.

Policy and Institutional Support: India's renewable energy policy is advancing with initiatives like the National Solar Mission, PM-KUSUM, and incentives like PLI to scale up projects and build a skilled green workforce.

International Collaboration: India's global leadership in IRENA and the G20 Energy Transitions Working Group attracts investments and promotes best practices, aiding the renewable energy transition through collaborative efforts. India faces challenges in achieving fully renewable-powered rural areas, but innovation, economic growth, and sustainable development opportunities are vast. Strategic policies, technology, and global cooperation can pave the way.

Conclusion: Vision for a Transformed Rural India

India's ambitious journey to renewable-powered rural areas combines policy initiatives, technology, and community involvement for economic growth, environmental sustainability, and improved rural life quality.

Economic Empowerment through Renewable Energy

- Renewable energy promises economic transformation in rural India with the goal of installing 500 GW capacity by 2030. The PLI scheme for solar PV modules aims to create jobs and attract investments. Decentralized renewable energy solutions like mini-grids and solar home systems provide reliable electricity to remote areas, boosting local businesses and curbing rural-urban migration for improved economic activities and quality of life.

Environmental Sustainability and Climate Resilience

- India aims to slash carbon emissions by 1 billion tonnes by 2030 and achieve net-zero by 2070 through extensive adoption of solar, wind, and other renewables, bolstered by supportive policies and declining costs. India reduces greenhouse gases and promotes sustainable agriculture by replacing diesel pumps with solar-powered ones, advancing through initiatives like PM-KUSUM and integrating solar irrigation systems for enhanced productivity and minimal environmental impact.

Enhancing Quality of Life

- Renewable energy in rural India enhances quality of life by providing reliable electricity for healthcare, education, and living standards. Solar cold storage reduces post-harvest losses, boosting income and food security. Renewable energy initiatives promote gender equality and social inclusion by training women to manage and operate systems, empowering them economically and fostering more equitable communities.

The Road Ahead

- Achieving a fully renewable-powered rural India is challenging yet promising. Success hinges on sustained policy backing, innovative technology, community involvement, financial accessibility, and integration with rural development programs.
- India aims for a renewable energy-dominant landscape by 2030, promoting economic growth, environmental sustainability, and rural quality of life. Sustained efforts can make this green and prosperous vision a global example.

ADOPTION OF DIGITAL TECHNOLOGY IN RURAL AREAS OF INDIA

Recognizing the potential for economic growth through ICT, the government is becoming a major player in global digital transformation. The Digital India Program (DIP) highlights inclusiveness, connecting rural areas with over 6 lakh km of optic fibre. By bridging the digital divide and promoting digital literacy, digitalization fosters a more inclusive society, benefiting marginalized communities.

Strategy

- The government launched the DIP initiative, led by Prime Minister Modi, to transform the nation using ICT tools, empowering India digitally and creating opportunities for its citizens.
- 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 aims to provide high-speed internet, mobile phones, and bank accounts, ensuring easy access to Common Service Centres and private cloud space. It strives for e-governance by enhancing online infrastructure and internet connectivity.

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 promotes universal digital literacy, participative governance, digital resources in Indian languages, and eliminates physical submission of government documents and certificates.

Adoption

India's internet presence is now 20% higher in rural areas than urban areas. Smartphones, UPI, and government schemes like the Pradhan Mantri Gramin Digital Saksharta Abhiyan have boosted access, while various organizations provide skill training and health awareness through technology.

Some sectors enabling rural populations with opportunities through digitisation: -

Education

The Indian edtech market is expanding in rural areas with free digital e-learning platforms like Diksha and E-Pathshala. These platforms offer educational resources, interactive lessons, and e-books in multiple Indian languages, promoting inclusive education.

Health

Indian digital healthtech, projected to generate \$37 billion by 2030, leverages NGOs, the private sector, and government through ASHA workers. The eSanjeevani app has facilitated over five million tele-consultations, aiding rural areas, and startups have digitized medical stores for remote access to medicines.

Agriculture

Around 70% of India's rural households depend on agriculture. Agritech startups and government apps like Karnataka's e-Sahamathi provide solutions such as soil testing, microfinance, and weather updates. These platforms enable farmers to share crop information and directly sell to retailers, allowing them to negotiate fair prices for their produce.

Economic Empowerment

The e-Shram portal by the Ministry of Labour and Employment serves as a digital hub for unorganised workers, offering job access and social security like pensions through the Shramik Card. This initiative integrates rural India into economic activities, leveraging the JAM trinity for enhanced connectivity and inclusion.

Women Empowerment

The government empowers rural women with loans, subsidies, and technology. NaMo Drone Didi trains women to pilot drones for agricultural tasks, acknowledging their significant role in the workforce. Digital platforms bridge knowledge gaps and enhance efficiency in farming, enabling direct market access for fair trade without 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.
- Empirical studies focused on rural areas are scarce, limiting understanding 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.

To tackle these challenges, collaboration among government, private sector, and civil society is crucial. Priorities include investing in digital infrastructure, expanding internet connectivity, and enhancing digital literacy and skills development programs to sustain Digital India in rural areas.

Digital Empowerment of Rural India

Digital technology has transformed lives, especially in rural areas, empowering and connecting people. The Digital India Program (DIP) has played a crucial role by enhancing access to technology through high-speed internet, improving digital literacy, and transforming rural services with advanced technology:

- 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.
- DIP has significantly raised community internet awareness in rural areas, ensuring widespread internet access and transforming these regions into digitally empowered societies.
- 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.
- Mobile phones provide farmers with crop price information, empowering them to make informed decisions and enhance agricultural practices, thereby boosting productivity and income in rural areas.
- DIP has been pivotal in fostering economic growth across rural and urban areas through initiatives like economic reforms, digitization, and smart cities, attracting FDIs and easing economic policies.
- DIP has enabled real-time education for rural communities, addressing teacher shortages through smart and virtual classrooms. Mobile devices educate farmers and fishers on advanced techniques, boosting productivity and livelihoods.
- High-speed internet in rural areas enables access to online education platforms, bridging the digital gap and offering 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

Government-led digitalization efforts have improved connectivity in rural India, bridging gaps and enabling access to digital services and information. This has transformed rural areas into digitally empowered societies with accessible wireless internet and e-services.

The Bharat Net project aims to enhance rural development by linking villages with high-speed broadband, boosting efficiency, cutting costs, and broadening access to crucial services. BSNL issued a tender for Bharat Net III to upgrade 164,000 gram panchayats and connect 47,000 using a ring topology model. Initiatives such as PMGDISHA have boosted digital literacy in rural areas, empowering residents to use digital tools for personal and professional advancement. India's adherence to global service standards has attracted international investments, drove economic modernization and enhancing export capabilities.

INNOVATIONS: DRIVER OF RURAL GROWTH AND DEVELOPMENT

With the R&D push in the Indian economy, the agricultural sector is embracing new innovations like the Soil Health Card (SHC). SHC helps producers understand soil fertility, promoting judicious use of fertilizers and reducing costs. This supports efficiency, addresses challenges, and sustains livelihoods.

- The National Agricultural Research and Education System (NARES) drives agricultural innovations in rural areas, such as the Sensor-Based Soil Moisture Meter and Leaf Colour Chart for efficient irrigation and crop nutrition.
- The Pusa Decomposer aids in decomposing paddy residues, reducing crop residue burning and improving soil fertility. The Happy Seeder supports timely wheat sowing, saves water, and reduces pollution. The Evaporative Cooling unit keeps produce fresh, preventing monetary losses.
- To encourage rural innovation, the Central Government runs several programs, including the Rural Technology Action Group (RuTAG) initiated by the Principal Scientific Advisory Council. RuTAG involves Indian institutes refining innovations in agriculture, biofuel, renewable energy, and more, partnering with 752 NGOs on 358 projects.
- In the first phase, 59 innovations boosting the rural economy have been implemented. RuTAG identifies the need for innovations in specific rural areas, presenting solutions and expanding scientifically recognized innovations, inspiring scientific development within rural communities.
- IIT Roorkee developed an evaporative cooling unit to reduce vegetable spoilage caused by high daytime temperatures. This eco-friendly innovation keeps stored vegetables cool and moist using a DC fan powered by a battery and foggers for humidity, preventing spoilage in both rural and urban areas.
- The Portable Oil Extractor (POE) is yet another innovation from RuTAG centre 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 varietal technologies for agricultural crops drive rural development by boosting production and income. High Yielding Varieties (HYV) enhance food security, while Biofortified Crops combat nutritional insecurities. Herbicide Tolerant Crops offer flexibility in herbicide use, effectively controlling weeds.
- Digital innovations are transforming rural areas, bridging technological and informational gaps. Internet-based mobile phones enable farmers to buy agricultural inputs online and address field issues using image-based apps. ICAR and SAUs have developed crop-specific (RiceXpert) and purpose-specific mobile apps (nXpert) to support farmers.
- ICAR's AI-DISC helps farmers take timely action against crop diseases. The e-National Agricultural Market (e-NAM) enables farmers to sell produce at competitive prices. IIT Bombay's Market Mirchi portal assists Farmer Producer Organisations and Self-Help Groups in direct sales, improving marketing efficiency and providing rural employment information.
- In animal husbandry, innovations include Mobile IVF units for superior germplasm, automated milking, and shearing machines to ease animal care, and Cage Farming for coastal fishermen to boost seafood production. India's first mobile IVF unit is in Gujarat's Amreli.

Entrepreneurial Innovations

- Innovation-driven entrepreneurship fuels rural development through agri-tech startups and enterprises, creating jobs and economic growth. Government initiatives like Start-up India and MUDRA loans support rural entrepreneurs, while social enterprises tackle local challenges with impactful solutions like Ninjacart, connecting farmers' produce with retailers and restaurants.
- AgriTourism and Home Stays are innovations attracting urbanites to experience rural life with urban amenities. Villagers in Madhya Pradesh's Orchha, Ujjain, Maihar, Amarkantak, and Dewas districts receive hospitality training from Bhopal's Hotel Management Institute. Chhattisgarh develops wedding destinations in Bastar and Surguja, with Jabra village in Dhamtari attracting foreign tourists. Uttarakhand promotes quality homestays with Rural Business Incubator support and government subsidies.
- Custom Hiring Centres (CHC) nationwide are an entrepreneurial innovation linking youth with agricultural machine owners to supply equipment to farmers for monetary gain. CHCs bring advanced technology to farmers, reduce agricultural labor, boost production efficiency, and create rural jobs. Drones are also widely used in agriculture for monitoring crops, surveys, and precise input application, with some firms offering custom hiring services to farmers.

Digital Innovations

- The digital revolution has bridged the urban-rural gap in India, driven by initiatives like Digital India. E-governance, digital payments, and online education now empower rural residents with accessible 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.
- The Central Government emphasizes digital inclusion to drive rural innovation, notably through the 5G Intelligent Village initiative. Villages like Dharmaj (Gujarat), Ramgarh (Uttar Pradesh), and others nationwide will benefit from advanced 5G technology for community development initiatives.
- The Meghdoot and Damini Apps from the Ministry of Earth Sciences innovate the agriculture sector. Meghdoot provides accurate weather updates, and Damini prevents casualties from lightning strikes.

Innovations in Education and Skill Development

- Education is pivotal for rural development. Innovations like digital classrooms and online learning platforms democratize access to quality education. The National Digital Literacy Mission aims to digitally empower every household member, promoting continuous learning.
- Skill development programs for rural youth, such as Pradhan Mantri Kaushal Vikas Yojana (PMKVY), provide vocational training in trades aligned with industry needs, enhancing employability in rural areas.

Healthcare Innovations

- Healthcare in rural India has improved with innovative approaches like telemedicine and mobile health clinics, making medical services accessible to remote areas. Patients can consult doctors and receive advice without traveling long distances.
- Innovations such as portable diagnostic devices and affordable medical equipment are improving healthcare quality. Maternal and child health programs, vaccination drives, and hygiene awareness campaigns are impactful in public health improvement.

Innovations in the Energy Sector

- Renewable energy innovations, like solar and wind power, are revolutionizing rural energy access in India. Solar lanterns, home lighting systems, and mini-grids provide reliable, affordable electricity, reducing reliance on conventional sources.
- The PM-KUSUM scheme promotes solar energy for irrigation, helping farmers cut costs and boost productivity, fostering sustainable and economically viable rural development.

Institutional Innovations

- In addition to sectoral innovations, institutional innovations like Farmer Producer Organisations (FPOs) provide comprehensive support to small farmers, from inputs to marketing. Self Help Groups (SHGs) address common challenges through mutual aid. The GS Nirnay app facilitates transparent Gram Sabha proceedings, supporting rural governance initiatives.
- Sarpanch Samvad, developed by the Quality Council of India, enhances Gram Sabha efficiency by enabling nationwide sharing of best practices among Sarpanchs and Panchayats. The water budget audit in Khargone district, Madhya Pradesh, ensures thorough water resource management, recording water allocation, usage, and conservation efforts.
- Currently piloted in Rasagangli, Chiklavas, and Gadgyam of Jhirnya district, this scheme plans to expand to 600 villages this year. It collects data on water inflow, usage, and wastage to guide the construction of water conservation structures like contour bunds, boulder checks, check dams, stop dams, and ponds. Kerala previously pioneered water budgeting to manage agricultural, horticultural, gardening, and plantation activities effectively during summer water crises.

Conclusion

- The convergence of innovative technologies, government initiatives, and community participation is driving holistic rural development in India. These innovations address traditional challenges and create new growth opportunities. By fostering innovation and scalable solutions, India can ensure its rural population thrives, supporting its journey to becoming a global economic powerhouse. The future of rural India is bright, and with sustained efforts, it will shine even brighter.

REBOOTING OPERATION FLOOD THROUGH AUTOMATION

India's dairy industry has grown significantly, with milk production increasing by 58% from 2014-15 to 2022-23, reaching 230.58 million tons. India holds a 24.64% share of global milk output. The top five states contribute 53.11% to the nation's milk production.

Success in any race risks complacency. The Indian dairy industry must now ask: what is next, and have all issues been resolved? Let's investigate:

- Launched in 1970, India's Operation Flood aimed to raise rural incomes, increase milk production, and supply affordable milk. By 1985, 43,000 village co-ops with 42.5 lakh producers were established. Milk production rose from 17 MT in 1947 to 222 MT in 2023, proving its success.
- In 2022, India's per capita fluid cow milk consumption was 59.98 kg, higher than China, Brazil, Russia, Japan, and South Korea, but lower than Belarus, New Zealand, Australia, the UK, and the US. Despite leading in milk production, India lags affluent nations in per capita milk consumption.
- The EU produced nearly 145 million metric tons of cow milk in 2022, with about 20 million dairy cows. Despite having over twice as many cows, India's average yield per cow is low, with 8.52 kg daily compared to the EU's 21 kg.

- Low productivity makes dairy unsustainable for many Indian farmers, leading to quality issues. Investigating "lower yield" may reveal problems with cattle management, veterinary health, climate change, and nutrition. Improved marketing of milk and dairy products is also crucial for higher farmer revenues.
- Farmers in many states complain of unfair milk prices, except in areas with strong cooperative dairies. High milk prices lead to a boom in fake and adulterated milk. In Assam, 26% of milk samples from the unorganized sector posed health risks, and in Punjab, 497 out of 1,400 samples failed safety standards in 2022-2023, indicating supply and demand imbalances affecting price parity.
- India needs Operation Flood Part II, driven by innovation and technology, to raise rural incomes and supply affordable milk. The dairy industry must address climate change impacts, high costs, and decreasing viability. Mechanization, automation, and innovation are essential for growth and sustainability, as livestock methane emissions contribute significantly to greenhouse gases.
- Automation and management of dairy farms improve animal health, lifestyle, milk quality, and profitability. Technology enables automated milk collection, composition testing, real-time procurement, and evaluation of quality indicators, providing crucial information on animal health, nutrition, and reproduction for balanced dairy production.

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

- **Automated Milking Systems:** Automated milking systems have revolutionized dairy farm management. Robotic milking equipment uses sensors to determine when cows are ready, attach milking equipment, and track milk flow, reducing labor costs and time, thus improving milk output and herd management. Robotic milking systems use sensors and cameras to identify cows, locate teats, and attach milking equipment. The technology monitors milk yield, quality, milking frequency, and cow behaviour in real-time.
- **Data-Driven Decision-Making:** Modern dairy farms rely on technology to collect and analyse data across operations, including monitoring cattle health and welfare through wearables and sensors. This data-driven approach enables timely detection and treatment of issues, resulting in healthier, more productive cows and increased milk production. Data collection is crucial, but processing and analysis are key for valuable insights. These decisions impact risk management, resource allocation, marketing strategies, and product development.
- **Precision Feeding:** Precision feeding, an advanced livestock nutrition approach, customizes diets with specialized technology to optimize animal nutrition, particularly in dairy farming. Automated systems adjust feed amounts based on each cow's needs, reducing waste and enhancing milk production and overall herd health.
- **Sustainable Practices:** Dairy producers are increasingly adopting sustainable practices using technology and automation to reduce environmental impact. Smart barns and automated irrigation systems conserve water and energy, while manure management technologies convert waste into biogas, further lowering environmental footprint.
- **Inventory and Supply Chain Management:** Effective resource management is critical for dairy farm profitability. Inventory management software tracks feed, medicine, and supplies to prevent shortages or overstocking, optimizing herd health and ensuring efficient milk collection and processing.
- **The Future of Dairy Farm Management:** Dairy farm management is advancing with artificial intelligence and robotics. These technologies handle tasks like sorting cows, cleaning barns, and even feeding with autonomous trucks. AI predicts health issues and behaviour in cows for proactive care.
- **Digitalisation:** Digitalization marks a critical next step for the dairy industry, enhancing efficiency and addressing current challenges. Areas like AI-driven predictive analysis, robotic milking, and livestock management are already seeing digital transformation, with more growth expected.
- **Cognitive Health & Dairy:** Since the pandemic began, concerns about declining cognitive health have risen. Individuals struggling with work-life balance, like homemakers, health professionals, and stressed students, are turning to functional meals, with dairy companies innovating in this area.
- **Dairy-based Sports and Nutrition:** Sports drinks, originally designed for athletes, provide hydration and energy but often contain sugar and additives. With growing health concerns, consumers prefer healthier options like milk, which offers essential nutrients including calcium, vitamin D, carbs, and electrolytes.

Milk's proteins, whey, and casein, aid muscle growth. As focus shifts towards health, milk is gaining traction as a post-workout rehydration choice, prompting innovative advancements in this field.

- **Reducing Greenhouse Gas Emissions:** Animal-derived food, including livestock feed, contributes 57% of the food industry's greenhouse gas emissions, twice that of plant-based diets. The food sector overall accounts for 35% of global greenhouse gas emissions. The dairy industry is prioritizing reductions in ruminant methane emissions by exploring sustainable feed innovations and forming partnerships to capture methane emissions.
- **Infant Nutrition:** There is a need for nutrition products because 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

- Recent technological advances have transformed the dairy farm industry globally, enhancing productivity, sustainability, and efficiency in operations. 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

- Dairy farms prioritize animal health and comfort through effective management systems. Digitizing operations maximizes livestock potential, with access to electricity, digital tools, smartphones, and superior technologies empowering farmers in managing their farms and monitoring animal welfare.
- Technology allows farmers to efficiently monitor large herds, saving resources through app-based systems that operate on multiple mobile devices. These tools track herd and cow performance, breeding and lactation cycles, vaccination schedules, and 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

- Technology and automation have revolutionized dairy farm management, making operations more efficient, economical, and sustainable. Automated milking systems, data-driven decision-making, precision feeding, and sustainable practices are key advancements driving this change. Technological advancements have enhanced every aspect of dairy farm management, optimizing nutrition through precision feeding, enabling informed decisions with data-driven analytics, and improving efficiency and cow welfare with automated milking systems.
- Technology's impact on dairy farm management is pivotal for future development, benefiting consumers and producers by enabling sustainable, high-quality dairy products.

RURAL INDIA: INNOVATION FOR INCLUSIVENESS

Innovation for development, as defined by the United Nations, involves leveraging cutting-edge concepts and tools to create positive impacts on people and the planet, enhancing resilience and fostering inclusive societies. India has made significant strides in the Global Innovation Index (GII), rising from 48th place in 2020 to 40th in 2023. In the GII 2023, India ranks first among 37 lower-middle-income economies in Central and Southern Asia. From 2001 to 2020, India's specialization in scientific and technological capabilities increased from 42% to 68% and from 9% to 21%, respectively. Innovation remains a cornerstone of India's progress, reinforced by government policies emphasizing inclusive development.

Between 2001 and 2012, telephone connections in India soared from 41 million to 943 million, with 911 million being mobile phones. This growth, coupled with declining tariffs and increased tele-density, positioned India as the fastest-growing telecommunications market globally, especially in Central and Southern Asia. Rural tele-density surged from 1.7% in 2004 to 58.5% in 2023, reducing the urban-to-rural tele-density ratio from 12.24 to 2.29. The Prime Minister Wi-Fi Access Network Interface (PM-WANI) scheme

aims to boost broadband access through public Wi-Fi hotspots, fostering internet penetration in rural areas and promoting inclusivity in rural communities.

Healthcare

- In rural areas, accessing quality healthcare is a challenge as most skilled professionals prefer urban settings. Digital innovations like e-Sanjeevani, India's national telemedicine service, have transformed rural healthcare, with over 241 million consultations conducted since its launch in 2019, benefiting primarily women and senior citizens.
- C-DAC, Mohali, in collaboration with MoHFW, India, developed e-Sanjeevani since 2018. It's tailored for over 1,55,000 Ayushman Arogya Mandir across India, using a Hub-Spokes model. At Health & Wellness Centres, community health officers facilitate teleconsultations with specialists in hubs at higher-level health facilities or medical colleges.

Education

- Urban-rural education disparities deepen social inequality, favouring urban children with better school and extracurricular choices. Internet access and educational apps have levelled opportunities, especially during the pandemic, enabling rural children to access world-class resources easily, aided by cheaper data and digital devices.
- AI integration enables personalized learning environments. Mobile apps, internet courses, and interactive platforms enhanced by AI algorithms offer accessible, high-quality educational materials. AI's expansive capabilities reduce costs, easing financial burdens associated with traditional teaching methods.

Banking and Finance

- Aadhaar-based banking has eased credit access for rural and underprivileged populations. Aadhaar streamlines KYC processes, leveraging its biometric authentication and database to enhance credit scoring and risk assessment. This facilitates tailored financial products and initiatives like the Credit Linked Subsidy Scheme for rural housing finance.
- Digital payment solutions like mobile wallets, QR code payments, and USSD services are transforming rural transactions. These secure and efficient methods enable residents to make purchases, pay bills, and transfer money digitally, fostering financial inclusion and economic growth. Agent banking further extends banking services by utilizing local businesses or individuals as agents, offering convenient access to basic banking transactions in remote rural areas.

Agriculture

- Around 70% of rural households rely on agriculture for livelihood. Challenges such as climate change, pest outbreaks, and limited access to insurance and market information worsen income disparities among farmers. Technological advancements offer potential for profitable and sustainable agricultural practices.
- Drones have revolutionized agriculture with precision spraying, crop monitoring, and soil assessment. AI-equipped drones enhance irrigation efficiency by detecting moisture levels. The Indian government subsidizes drone purchases, covering up to 50% (Rs. 5.00 lakhs) for certain farmers and 40% (Rs. 4.00 lakhs) for others.
- Farm insurance digitization has expedited claim processing. Mobile apps linked to crop insurance enable farmers to access coverage details, calculate premiums, and report losses. Initiatives like WINDS improve weather data collection, aiding insurance accuracy. Apps like Kisan Call Centre provide agricultural information and market updates.

Access to Clean Water

- According to WHO, access to safe drinking water means having at least 20 liters per person per day from a nearby improved source. In urban areas, 98.7% have access, compared to 94.6% in rural areas, impacting health, education, and earning potential. Startups like Boon (formerly Swajal) use solar-powered water ATMs to democratize access, impacting over 20 lakh people across 140 Indian villages.

- Groundwater overuse and limited monitoring challenge rural water management. The Bhujal app, a unique Android tool, swiftly measures borewell water levels, aiding farmers in efficient planning and preventing premature well depletion, thus saving electricity.
- Kheyti addresses water scarcity for small farmers with its Greenhouse-in-a-Box, reducing climate risks and boosting yields. The greenhouse uses 90% less water than outdoor farming, increases yields seven-fold, and is cost-effective, enhancing farm incomes for investing in healthcare and education.

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.