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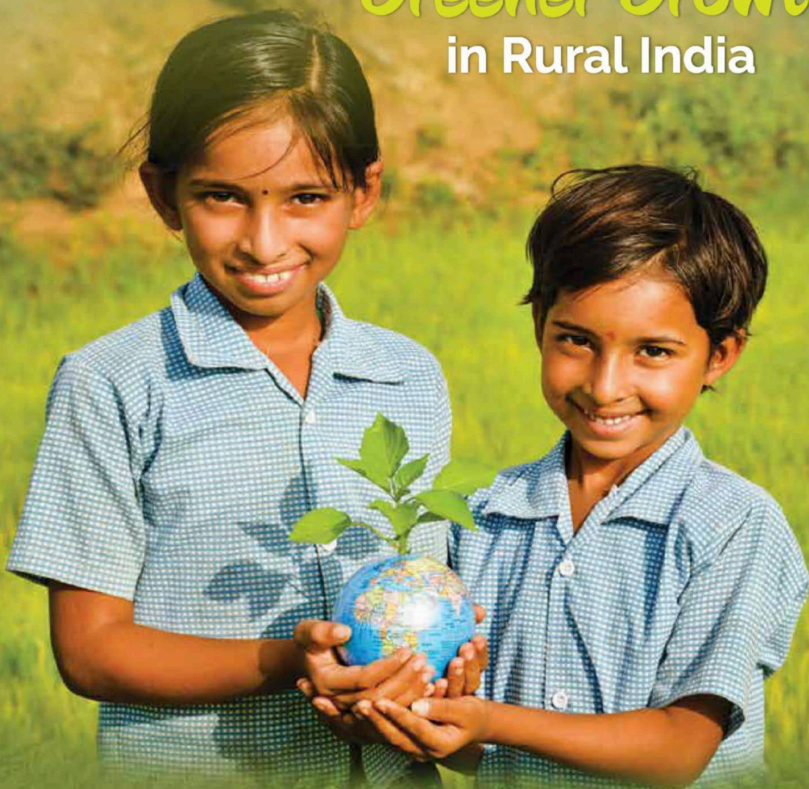
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in Rural India



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Empowering
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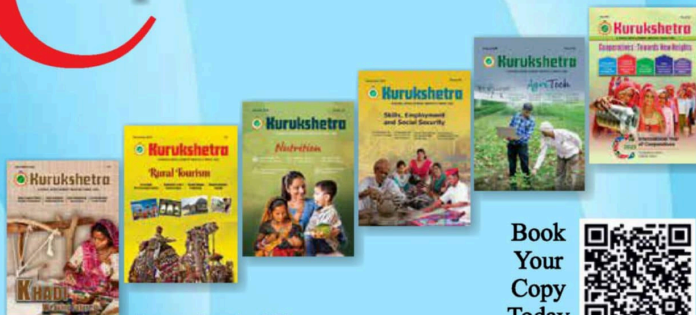
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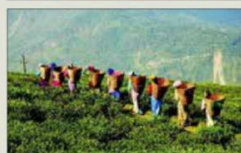
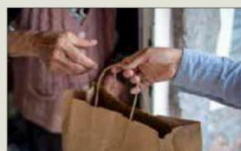
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India's development journey today is closely linked with how effectively it balances economic growth with environmental sustainability, especially in its villages. Rural India, where a majority of the population resides, depends heavily on natural resources for livelihoods and is highly vulnerable to climate change, water scarcity, and environmental degradation. This makes the shift towards green growth not just desirable, but essential.

Green growth in rural India means improving livelihoods while protecting the environment through sustainable farming, clean energy, efficient water management, and eco-friendly infrastructure.

Agriculture remains central to this transformation. While it supports millions of rural households, unsustainable practices have led to soil degradation, water depletion, and increased emissions. Promoting natural farming, organic agriculture, and agroforestry can improve soil health, reduce chemical use, and enhance resilience to climate change while also opening new income opportunities for farmers.

Energy access is another key pillar. Reliable and clean energy can transform rural life by improving productivity and reducing costs. The expansion of solar pumps, biogas plants, and energy-efficient technologies is helping provide affordable and dependable energy to rural households while reducing emissions.

However, policies alone are not enough; their success depends on effective implementation. Convergence of government schemes and better coordination can significantly enhance impact, particularly when aligned with water conservation, sanitation, and renewable energy initiatives.

Community participation is equally important. Green growth requires active involvement from villagers. Panchayats, Self-Help Groups, and farmer organisations play a key role in spreading awareness and encouraging sustainable practices. Women, in particular, have emerged as leaders in areas such as organic farming, waste management, and clean energy adoption.

Despite these efforts, several challenges remain. Many Gram Panchayats lack technical expertise and financial resources, and awareness about sustainable practices is uneven. Farmers may also hesitate to adopt new methods due to initial costs or perceived risks. Limited coordination between departments further reduces efficiency.

To move forward, India must strengthen local institutions and invest more in capacity-building at the grassroots level. Improved coordination, supported by digital monitoring systems, along with awareness campaigns and incentives, can encourage wider adoption of sustainable practices.

Green growth in rural India is not just about protecting the environment—it is about securing livelihoods, improving quality of life, and building resilience for the future. If pursued effectively, it can transform villages into centres of sustainable development, ensuring that progress is both inclusive and environmentally responsible. □



Nurturing Young Minds for India's Future

The environmental challenges of the 21st century climate change, biodiversity loss, pollution, and resource depletion require urgent and sustained action. A key long-term strategy lies in fostering environmental awareness and responsibility among children and youth. This article examines the role of nurturing 'green minds' in advancing a sustainable India under the vision of 'Viksit Bharat'. It highlights the importance of early environmental education, supported by experiential learning, in shaping attitudes and behaviours. The role of schools, families, and communities in reinforcing sustainable practices is explored, alongside youth-led initiatives and everyday actions. Creative approaches such as gamification and storytelling further enhance engagement. Strengthening youth participation is essential for building a greener, more resilient future.

Dr. Rabindranath Lenka

The future of environmental sustainability will be determined not only by policies and technologies, but by the values and actions of today's young generation. India stands at a critical juncture where sustainability is central to its vision of 'Viksit Bharat'. A sustainable future is not an abstract vision; rather, it is a responsibility

that begins with the choices we make today. Among the most powerful agents of change are children and youth whose attitudes, habits, and values will shape the environmental future of India. Nurturing young minds is, therefore, not merely an educational goal, but a national priority. By fostering awareness early in life and encouraging practical, everyday actions, we can inspire young people to become responsible stewards

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of the environment and active participants in building a greener India.

It has been aptly stated that ‘protecting and conserving crucial ecological systems and resources is essential for livelihoods and welfare’ and that ‘environmental resources must be used judiciously to meet the needs of the present generation without compromising the aspirations of future generations’ (National Environment Policy, 2006). This underscores the need to integrate environmental concerns into plans, policies, and practices for socio-economic development, as well as to apply principles of good governance in managing and regulating environmental resources for a ‘Viksit Bharat’.

The National Action Plan on Climate Change (NAPCC) outlines a national strategy aimed at enabling the country to adapt to climate change and enhance the ecological sustainability of its development pathway. It emphasises that maintaining a high growth rate is essential for improving the living standards of the majority of India’s population and reducing their vulnerability to climate impacts (NAPCC, 2021).

Further, the Swachh Bharat Mission (Gramin) Guidelines emphasise environmental awareness and cleanliness, highlighting the need to improve the general quality of life in rural areas by promoting hygiene and eliminating open defecation (Swachh Bharat Mission Guidelines, 2018). Similar efforts have also been undertaken in urban areas under Swachh Bharat initiatives.

The National Education Policy (NEP) 2020 envisions the integration of environmental sustainability into the Indian education system to cultivate environmentally conscious and responsible global citizens. It further advocates a holistic approach by incorporating experiential learning, multidisciplinary education, and traditional Indian knowledge systems into the curriculum (NEP, 2020).

The Need for Early Environmental Awareness

Environmental challenges such as climate change, pollution, deforestation, and bio-diversity loss are no longer distant concerns; they directly affect daily life through extreme weather events, water scarcity, soil erosion, and declining air quality. For young people growing up in this reality, awareness is the first step towards meaningful action. When children understand

the connection between human activities and environmental consequences, they begin to perceive themselves as part of the solution.

In this context, early environmental awareness becomes particularly significant, as habits formed during childhood tend to persist throughout life. A child who learns to conserve water, minimise waste, and respect nature is more likely to carry these values into adulthood.

Role of Environmental Education in Shaping Young Minds

Environmental education plays a crucial role in building the knowledge, attitudes, and skills necessary for sustainable living. It goes beyond textbook learning to encourage critical thinking and problem-solving abilities. By understanding ecosystems, climate systems, and resource management, students gain deeper insights into how the natural world functions and how human actions affect it.

However, the effectiveness of environmental education depends on its ability to connect theory with practice, and classroom learning with real-life experiences. As highlighted in the Samagra Shiksha Guidelines, ‘education is the most important tool for social, economic, and political transformation, and a key instrument for building an equitable society’ (Samagra Shiksha Guidelines, 2018). Such an equitable society requires:

- Building environmental awareness at an early age
- Developing responsible and sustainable behaviour among children and youth
- Enhancing critical thinking and problem-solving skills
- Fostering an emotional connection with nature
- Encouraging community participation and civic responsibility
- Integrating environmental efforts with the Green India Mission and other national initiatives
- Promoting environmental education in schools (Eco-Clubs and curriculum integration)
- Supporting skill development and livelihood awareness through green initiatives
- Strengthening climate action through youth engagement
- Creating a foundation for a sustainable and ‘Green India’, among other goals

Role of Schools in Promoting Green Habits and Nurturing Green Minds

Schools play a pivotal role in shaping how children understand and interact with the world around them. In the context of building a sustainable future, they serve as the first structured environment where environmental awareness can be systematically introduced, practised, and reinforced.

One of the most significant contributions of schools is the integration of environmental education into the curriculum. Subjects such as literature, science, social studies, and geography naturally lend themselves to discussions on climate change, biodiversity, pollution, and conservation. However, the true impact lies in moving beyond textbook instruction and promoting experiential learning. When students engage in activities such as observing local ecosystems, maintaining gardens, or conducting environmental projects, they begin to understand the real-life relevance of these concepts.

Equally important is the role of schools in cultivating everyday green habits. Simple practices such as switching off lights and fans when not in use, minimising paper waste, carrying reusable water bottles, and segregating waste can be embedded into the school routine. Such habits, when developed early, tend to persist throughout life and influence responsible behaviour.

Schools also serve as platforms for collective action through initiatives such as eco-clubs, tree plantation drives, and cleanliness campaigns, which provide students with opportunities to participate actively in environmental protection. Teachers play a central role in this process as facilitators, mentors, and role models.

Another important aspect is the development of a green school environment. Institutions can adopt practices such as rainwater harvesting, the use of solar energy, effective waste management systems, and the maintenance of green campuses. Moreover, schools act as bridges between students, families, and communities, promoting the adoption of eco-friendly practices beyond the classroom. In this way, the impact of school-based environmental education extends to society at large.

Role of Families in Nurturing Green Minds

Families constitute the earliest and most influential environment in a child's life. Long before formal

SUSTAINABLE PRACTICES FOR NURTURING GREEN MINDS

-  Practicing Water Conservation in Daily Life
-  Reducing, Reusing and Recycling Waste (3Rs)
-  Using Eco-Friendly Alternatives
-  Planting and Caring for Trees and Plants
-  Saving Energy at Home and School
-  Participating in Cleanliness Drives
-  Promoting Sustainable Transportation
-  Spreading Environmental Awareness
-  Practicing Responsible Consumption
-  Engaging in School Eco-Clubs and Green Activities.

education begins, children observe, imitate, and internalise the habits and values practised at home. This makes families essential in fostering environmental awareness and nurturing green minds that can contribute meaningfully to a sustainable India.

One of the most effective ways families promote sustainability is through everyday behaviour and cultural practices. Simple actions such as conserving water, switching off unused appliances, reducing food waste, and avoiding single-use plastics serve as practical lessons in environmental responsibility. When eco-friendly habits are consistently practised at home, they become an integral part of a child's routine and mindset.

Families also play a key role in shaping attitudes towards consumption. By encouraging mindful purchasing, reusing household items, and valuing resources, parents can teach children the importance of reducing waste and avoiding unnecessary consumption. Engaging children in discussions about why certain choices are environmentally responsible helps deepen their understanding and strengthens decision-making skills from an early age.

Another significant contribution of families lies in fostering a connection between children and nature. Activities such as planting trees, maintaining home gardens, visiting parks, or simply spending time outdoors help children appreciate the value and beauty of the natural world. This emotional connection often leads to a stronger sense of responsibility towards environmental conservation.

Families also act as a crucial bridge between knowledge and practice. What children learn in school

Youth-led Initiatives and Success Stories in India

- 1. Green Rising Initiative (India Alliance):** This global youth-led climate action platform, launched with the support of UNICEF and India's Ministry of Environment, mobilises young people to undertake grassroots climate actions such as afforestation, awareness campaigns, and sustainable practices. It highlights the power of collective youth engagement in addressing climate challenges at the community level.
- 2. Natural Farming Fellows Programme (Sustainable Agriculture by Youth):** This programme encourages young graduates to adopt natural farming practices, thereby promoting eco-friendly agriculture and rural sustainability. It contributes to reducing chemical dependency while improving soil health and long-term agricultural resilience.
- 3. Green Yatra – Green Youth Green India Campaign:** This initiative actively engages college students across India in sustainability campaigns, including tree plantation drives, recycling activities, and green campus programmes. It fosters environmental responsibility and leadership among youth.
- 4. Youth of India Foundation Environmental Programmes:** The organisation works extensively on environmental awareness, conservation, and sustainable practices. It empowers young individuals to participate in climate action, community campaigns, and policy advocacy, reinforcing the idea that youth are key drivers of sustainable development and environmental resilience in India.
- 5. Youth-Led Organic Farming in Maharashtra:** In regions such as Ahmednagar, young farmers have adopted climate-smart and organic farming practices under various youth-led initiatives. These practices reduce water usage, improve soil health, and enhance productivity. This example demonstrates how youth engagement in sustainable agriculture can balance environmental conservation with economic benefits for rural communities.
- 6. Yuva Sansad for Environmental Policy Engagement:** The Yuva Sansad initiative has engaged hundreds of young participants in presenting ideas related to sustainable development and environmental policy to local governance bodies. This platform enables youth to contribute to decision-making processes, demonstrating their potential to influence policy and promote sustainability at institutional levels.
- 7. Student-Led Recycling Drives in Vijayawada:** School students organised large-scale recycling campaigns by collecting used books and paper for reuse. Their efforts contributed to saving trees, water, and energy, while reducing carbon emissions. This initiative highlights how school-level engagement can create measurable environmental impact and instil sustainable habits early in life.
- 8. Youth-Led Nature Clubs and Campus Initiatives in Lucknow:** Recent efforts to establish nature clubs in higher educational institutions have encouraged students to participate in environmental conservation activities. These clubs promote awareness campaigns, green practices, and sustainability programmes, thereby institutionalising environmental responsibility among youth.
- 9. Fridays for Future India (Climate Activism by Students):** Inspired by global movements, students across India organise climate strikes, campaigns, and awareness drives. These initiatives advocate for stronger climate policies and raise public awareness, demonstrating the growing influence of youth voices in environmental governance and public discourse.
- 10. Enactus India (Sustainable Entrepreneurship by Youth):** This student-driven platform empowers young individuals to develop eco-friendly business solutions. Its projects focus on waste management, sustainable livelihoods, and green innovation. By integrating entrepreneurship with environmental objectives, it illustrates how youth can contribute to sustainability through innovation and economic activity.

All the case studies shared clearly demonstrate that youth in India are not merely passive learners, but active leaders in environmental conservation and the creation of a 'Green India'. Through innovation, participation, and community engagement, they are shaping a greener India and contributing to the vision of 'Viksit Bharat' with a sustainable future.

becomes meaningful when it is reinforced at home. For instance, lessons on recycling or water conservation gain real value when implemented in daily household activities. This consistency between school and home environments ensures that environmental education is not confined to theory but evolves into a way of life. In addition, families can encourage participation in community initiatives such as cleanliness drives, plantation programmes, and awareness campaigns. Ultimately, families lay the foundation for lifelong values and habits.

Sustainable Green India and the Role of Communities

Communities form the social fabric within which children and youth grow, interact, and learn beyond the boundaries of home and school. They play a vital role in transforming environmental awareness into collective action. When sustainability becomes a shared community value, it creates an ecosystem where green habits are practised, reinforced, and celebrated, thereby shaping young minds towards a greener India.

The role of communities includes fostering collective responsibility and organising initiatives such as cleanliness drives, tree plantation campaigns, and waste segregation programmes. Furthermore, communities play an important role in promoting eco-friendly practices by organising environmentally conscious events, cultural programmes, and festivals that integrate traditional knowledge with sustainability. Such initiatives help in raising awareness while preserving cultural values. Above all, communities contribute to building a culture of sustainability within the social environment.

Creative Approaches to Make Sustainability Engaging and Actionable

Creative methods can transform environmental awareness into meaningful action, making the journey towards a greener India both engaging and impactful. Some key approaches include:

- Connecting learning with the real-life experiences of children and youth
- Inspiring behavioural change for a greener India
- Promoting learning through play, activities, and gamification
- Encouraging hands-on experiential learning
- Using storytelling and creative expression

- Integrating technology with everyday life through digital platforms
- Promoting project-based learning linked to real-life experiences
- Encouraging peer learning and purposeful youth leadership
- Incorporating local contexts and cultural practices
- Recognising talent and providing incentives
- Promoting community-based engagement in everyday life
- Linking sustainability with daily habits

Thus, creative approaches make sustainability not only understandable but also engaging and actionable for children and youth. By combining enjoyment, participation, and real-life relevance, these methods nurture green minds that are aware, responsible, and proactive.

Conclusion

Nurturing green minds is a collective responsibility that requires the active involvement of schools, families, communities, and young individuals. By creating awareness, promoting practical habits, and encouraging participation, children and youth can be inspired to become responsible environmental stewards. The journey towards a sustainable India begins with small yet meaningful actions taken by millions of individuals. When young minds are empowered with knowledge, guided by values, and supported by enabling environments, they possess the potential to transform society through sustained and responsible action.

A greener India aligned with the vision of 'Viksit Bharat' is not merely an aspiration but an achievable reality shaped by the actions of today's youth. National initiatives such as the Jal Jeevan Mission aim to provide safe and adequate drinking water to every rural household, addressing challenges related to water scarcity and management (Jal Jeevan Mission, 2019). Similarly, the Lifestyle for Environment (LiFE) Movement, supported by NITI Aayog, promotes sustainable lifestyles by emphasising the integration of technology and traditional knowledge, along with the idea that collective individual actions can drive large-scale environmental change (LiFE Movement, NITI Aayog, 2022). These collective efforts contribute significantly to the cultivation of green minds and the realisation of a sustainable and resilient Green India. □



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Empowering SHGs for Green Action

Driving Inclusive Climate Action through Community Institutions

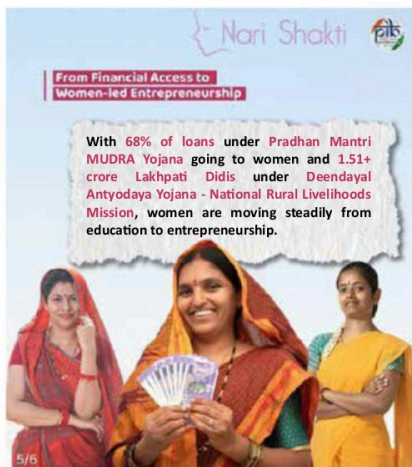
Climate change is no longer a distant concern but a lived reality shaping rural livelihoods and development pathways in India. In the emerging discourse on women-led development as a core pillar of the 'Viksit Bharat' agenda, reconsidering the role and potential of Self-Help Groups (SHGs) becomes a crucial strategy. SHGs can contribute not only to addressing challenges related to climate change and biodiversity loss but also to advancing inclusive and sustainable rural development. With strong community linkages and social capital, they are uniquely positioned to promote green livelihoods and local climate action. This article explores strategies to strengthen SHGs as effective drivers of climate-resilient development.

Partha Pratim Sahu

Improving and sustaining livelihoods through group-based interventions has emerged as a significant development approach to address various rural challenges. Self-Help Groups (SHGs) have evolved into effective platforms for collective action,

based on the premise that mobilising marginalised and economically weaker sections particularly women and organising them into groups enhances their capacity to participate meaningfully in the development process. This, in turn, improves targeting and strengthens rural development outcomes.

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Over time, SHGs have expanded beyond savings and microfinance activities to include micro-enterprise development, skill building, and livelihood generation. They also play an important role in facilitating access to public services such as health, education, and nutrition.

In the context of emerging priorities such as climate change, the circular economy, waste to wealth initiatives, and strengthening local economies through the 'Vocal for Local' movement, re-examining the role and potential of SHGs becomes essential. Leveraging SHGs in these areas can serve as a strategic pathway towards achieving inclusive and sustainable rural development.

Key Issues and Concerns

Rural India is increasingly affected by climate change, facing challenges such as shifting rainfall patterns, rising temperatures, and extreme weather events including floods, droughts, and cyclones. Addressing the impacts of climate change has become one of the most critical challenges of this century, not only for governments, but also for communities and businesses. These impacts threaten the foundations of India's natural environment and have far-reaching consequences for its social and economic systems. Therefore, it is essential to prepare for both the current and anticipated impacts of climate change in the coming years. The key challenge lies in developing

a climate-resilient development framework that is socially inclusive and gender-responsive, while ensuring environmentally and economically sustainable livelihoods.

In recent years, under the National Rural Livelihood Mission (NRLM), several interventions have been implemented to enhance livelihoods and incomes. These include value chain development for high-value farm and non-farm commodities, as well as enterprise promotion initiatives. Programmes such as *Lakhpati Didi*, the *Start-up Village Entrepreneurship Programme* (SVEP), and the *Aajeevika Grameen Express Yojana* (AGEY) focus on developing Community Resource Persons – Enterprise Promotion (CRP-EP) as local mentors to support rural women in starting or expanding small businesses. The Government of India has also made efforts to build a supportive ecosystem for women entrepreneurs.

Despite these initiatives, only a limited number of SHGs have been able to transform into productive and sustainable business entities. A large proportion of SHGs continue to operate at a subsistence level and have not been able to scale up their economic activities. Furthermore, SHG-based enterprises remain highly vulnerable to climate change due to limited awareness, inadequate skills related to resource efficiency, and weak infrastructure.

Climate change impacts can affect multiple dimensions of these enterprises, including physical infrastructure, production processes, supply and value chains, workforce stability, and access to markets and finance. Many SHG enterprises lack the capacity to assess, monitor, and adapt to climate-related risks. The effects of climate variability are already visible, for example, in frequent energy (electricity) and water shortages during summer months.

At the same time, climate change also presents new opportunities for innovation and enterprise development. These include the creation of climate-resilient products and services that cater to emerging needs of communities and markets. Leveraging such opportunities can help SHGs transition towards more sustainable and resilient business models.

Opportunities and Challenges

Over the past decade, the National Rural Livelihoods Mission (NRLM) has contributed to a significant

Waste to Wealth

There are numerous inspiring examples of women-led sustainability initiatives across India that need to be documented and disseminated for wider replication and scaling. This case highlights the inspiring journey of Ms Kamala Moharana, a 64-year-old woman from a village in Kendrapara district, Odisha. She leads the Ma Thanapati Self-Help Group, established in 2016, comprising around 30 women members.

The group is engaged in converting plastic waste such as milk pouches, polythene bags, and food wrappers into value-added products including baskets, pen stands, mobile stands, flower pots,

hand fans, and decorative items. By collecting and recycling waste materials on a daily basis, the group contributes significantly to reducing environmental pollution.

The initiative gained national recognition when it was mentioned by the Prime Minister in *'Mann Ki Baat'*, following which it received appreciation from various leaders and officials. Today, the activity serves as a sustainable source of income for the women while also promoting cleanliness and environmental awareness in the community. Under her leadership, many rural women are successfully transforming waste into wealth.

transformation in women's social and economic opportunities in rural India through their participation in Self-Help Groups (SHGs). Collectivisation through SHGs has enhanced women's aspirations, mobility, and agency within households as well as in the wider community. Currently, there are over **13.4 million SHGs**, with nearly **100 million active members** across India, most of them are women from poor and marginalised communities.

These grassroot institutions, characterised by strong community linkages, trust, financial inclusion, and established organisational structures, are well positioned to promote climate awareness, sustainable practices, and green solutions at the local level. Strengthening SHGs through capacity building, mentoring, handholding support, and integration with a robust institutional ecosystem can significantly enhance community resilience while contributing to India's climate commitments.

There are several strategic areas where SHGs can effectively contribute to climate adaptation and mitigation through localised solutions tailored to community needs. Sustainable agriculture such as organic and natural farming, use of bio-fertilisers, composting, and reduction of chemical inputs is being actively promoted under NRLM across states. SHGs are also playing an important role in promoting climate-resilient agricultural practices, including Integrated Farming Systems (IFS), kitchen gardens, use of climate-resilient seeds, and adoption of soil health cards.

In the domain of water conservation and watershed management, SHGs contribute not only by mobilising communities but also by participating in the planning and implementation of activities such as construction of check dams, rainwater harvesting structures, and soil conservation measures. The role of SHGs, along with local institutions such as Panchayati Raj Institutions (PRIs), has been clearly recognised in the PMKSY (WDC) 2.0 guidelines.

SHGs have also demonstrated strong potential in waste management and the circular economy. In several states, they are actively engaged in solid and liquid waste management. Their role extends beyond collection, segregation, and recycling to include value addition through converting waste into useful products such as bags, mats, and handicrafts made from materials like water hyacinth.

Furthermore, SHGs are increasingly exploring renewable energy solutions, particularly solar energy. In some cases, they function as energy entrepreneurs by producing, distributing, or maintaining solar lanterns and lighting systems. In forest and tribal-dominated regions, SHGs play a critical role in the sustainable management of common resources, responsible utilisation of non-timber forest products (NTFPs), forest restoration, and preservation of indigenous knowledge systems. Across these domains, SHGs contribute not only to livelihood generation but also to environmental sustainability and climate adaptation and mitigation efforts (Box 1).

Box 1: SHGs based Case Studies / Best Practices across Indian States

Interventions	State	Key features
Kudumbashree Model	Kerala	- Women-led waste management enterprises - Organic farming
Zero Budget Natural Farming (ZBNF)	Andhra Pradesh & Telangana	- SHG-driven natural farming
“Palash” Branding Initiative	Jharkhand	- SHGs products honey, pulses, handicrafts marketed under a common brand and promoting sustainable green livelihoods
MAVIM Model	Maharashtra	- Sustainable agriculture and nutrition gardens - SHGs linked with value chains and cooperatives
Waste to Wealth SHGs	Odisha	- SHG women create products from textile waste and plastic waste
NTFPs / Forest-Based Livelihoods	North eastern states	- Bamboo crafts - Products from water hyacinths - conservation + livelihood integration

Despite these opportunities, several challenges and barriers have limited the replication and scaling up of such initiatives. Many rural communities lack access to reliable climate information, technical knowledge, and training required to adopt appropriate solutions. Sensitising communities about climate change should, therefore, be the first step in enabling local action. This can be achieved through the following measures:

- a) Conducting special Gram Sabhas** (community meetings), facilitated by NGOs, government agencies, and Farmer Producer Organisations (FPOs), to provide climate education using localised data, vulnerability assessments, and future projections;
- b) Building the capacity of SHG members** to integrate climate concerns into the preparation of Village Prosperity and Resilience Plans (VPRPs), and ensuring their effective integration into Gram Panchayat Development Plans (GDPDs);
- c) Providing regular capacity-building support** to SHGs on practical climate actions such as climate-resilient agriculture, water conservation, and clean energy adoption.

Climate-resilient livelihoods can be further promoted through the adoption of practices such as resilient agriculture, integrated pest management, mixed cropping, and agroforestry. SHGs can also play a key role in enabling decentralised clean energy access in rural areas by facilitating the distribution of renewable energy products, installation of community-

level microgrids and biogas plants, and promoting the adoption of electric mobility solutions. These initiatives can be strengthened by improving SHGs access to climate finance, along with building their capacities in proposal development, financial management, and impact monitoring.

Way Forward

While Self-Help Groups (SHGs) demonstrate immense potential to drive grassroots climate adaptation and mitigation, this potential remains largely untapped. The role and potential of SHGs have been recognised in various micro-planning tools, including the Gram Panchayat Development Plan (GPDP), Village Disaster Management Plan (VDMP), and centrally sponsored schemes such as Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) (now Viksit Bharat—Guarantee for Rozgar and Ajeevika Mission (Gramin)) and Pradhan Mantri Krishi Sinchayee Yojana, Watershed Development Component 2.0 (PMKSY–WDC 2.0). However, training and capacity-building efforts particularly on climate change-related issues remain inadequate.

India has a large cadre of Community Resource Persons (CRPs), including *Kisan Sakhi/Krishi Sakhi*, *Pashu Sakhi* (Livestock CRP), *Doctor Didi*, NTFF CRP, *Matsya Sakhi* (Fisheries CRP), *Udyog Sakhi* (Value Chain CRP), CRP—Enterprise Promotion (CRP-EP), *Bank Mitras*, e-CRPs, *Setu Didi*, *Tablet Didi*, and *Patrakar Didi*,



function as ‘hyper-local platforms’ or nodal points for addressing climate-related issues by coordinating with stakeholders such as government departments, NGOs, CSR partners, and community institutions. This can help in creating an enabling ecosystem for SHGs to expand and scale up climate-resilient livelihood opportunities.

Panchayats should also actively facilitate awareness among SHGs regarding various schemes and programmes related to enterprise development, particularly those for which they are eligible. Additionally, best practices and successful initiatives across states should be systematically documented

among others, who play a critical role in implementing rural development programmes. There is a need to strengthen their capacities through regular and structured training programmes, with a specific focus on climate change awareness and skills required to promote climate-resilient livelihoods.

The Gram Panchayat Development Plan (GPDP) can play a pivotal role in integrating climate concerns at the grassroots level. Special Gram Sabhas should be organised not only to sensitise communities about climate change but also to identify and prioritise local challenges. Panchayat secretariats can

and widely disseminated to support replication and scaling up.

The existing SHG network has significant potential to catalyse grassroots climate action and promote localised solutions, particularly for vulnerable communities. This requires targeted capacity-building programmes, improved access to financial resources, stronger institutional partnerships, and the promotion of decentralised leadership. Strengthening these dimensions will be crucial in unlocking the full potential of SHGs in advancing climate-resilient and sustainable rural development. □



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Green Growth in Villages

Turning Policies into Realities

India's green transition strategy over the past few decades has been increasingly anchored in rural transformation. This study examines how national policies across water, energy, agriculture, waste management, and local governance drive measurable outcomes at the village level. It analyses major initiatives such as VB-G RAM G, JJM, PKVY, NMNF, PM-KUSUM, Gobar-Dhan, and GPDP, along with state experiences. The findings highlight that convergence of schemes, strong local institutions, community ownership, ongoing investment in local institutions, and performance and results-based monitoring are essential for achieving effective and sustainable green growth in rural India. While significant progress has been made in renewable energy and sustainable agriculture, it is essential for India to develop a sustainable model for the future.

Dr. Neelam Patel
Sambuddha Goswami
Himanshu Dev

The trajectory of development in India will increasingly be determined by whether economic growth and environmental sustainability can coexist or conflict. This issue is particularly important for rural India, where nearly

65% of the total population lives and where about 47% of the total labour force is employed in agriculture, including all associated activities. Agricultural land cultivated by these communities, water resources they use, and ecosystems on which they depend for rural livelihoods are critical to daily rural lives and are

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also areas of significant climate-related vulnerabilities (Gol 2023). This context provides a critical aspect of India's transition to a greener economy. To fulfil the commitments articulated in India's updated Nationally Determined Contribution (NDC) (MoEFCC, 2022), which seeks to achieve:

- (i) a reduction of 45% in GHG (Greenhouse Gas) emission intensity from Indian GDP by 2030 relative to GHG emission levels in 2005
- (ii) 50% of India's electricity generation capacity to be from non-fossil fuel sources, and
- (iii) an additional carbon sink of 2.5–3.0 billion tonnes of CO₂ to be created through afforestation activities by 2030, rural sectors must play an integral role in achieving these national goals, thus bridging the policy implementation gap. Over the last decade, India has substantially developed its policy framework to facilitate such a transition; the key to successfully delivering these goals will be to assess the effectiveness of existing policies in bridging the gap between policy design and their successful implementation.

The Conceptual Framework of Policy Foundation

India's rural green growth vision is based on a set of dynamic national programs that "converge" uniquely across multiple sectors to address critical and interrelated areas of focus, including water, energy, waste, livelihoods and agriculture. These programs create an integrated foundation for transforming national goals into action at the village level. Viksit Bharat–Guarantee for Rozgar and Aajeevika Mission (VB-GRAM-G) establishes the groundwork for ecological balance and employment; the Jal Jeevan Mission (JJM) supports future sustainable water systems; Paramparagat Krishi Vikas Yojana (PKVY) and the National Mission for Natural Farming (NMNF) are aimed at making agricultural practices more economically and environmentally viable through the elimination of chemicals; Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyaan (PM-KUSUM) supports the transition to decentralized solar energy;

What is Green Growth?

"Green growth means fostering economic growth and development while ensuring that natural assets continue to provide the resources and environmental services on which our well-being relies." (OECD, 2011).

Galvanizing Organic Bio-Agro Resources Dhan (Gobar-Dhan) is based on the circular economy; and, GPDP provides an effective institutional infrastructure for comprehensive local planning with the goal of a "Clean and Green Village."

Lessons Derived from an Empirical Setting

Regardless of how well-designed the policy intent is, it must be able to survive the many different versions of local realities. Various states in India that have made major advances toward actualising a green growth agenda were able to do so by aligning the essential elements of formal stable institutions within their jurisdiction with community engagement, creating exemplary models of development from which lessons can be derived.

Tamil Nadu: Institutional Innovation and Ownership at the District Level

An example of institutional innovation in the State of Tamil Nadu demonstrates how a small amount of rethinking can lead to transformational changes. In August of 2023 the Chief Minister of Tamil Nadu launched the Chief Minister's Green Fellowship Programme and deployed 38 trained and qualified Green Fellows in the 38 districts of Tamil Nadu to support the promotion



A rural woman accesses clean tap water under the Jal Jeevan Mission, transforming daily life across India's villages

Table 1: Policy Architecture for Advancing Green Growth in Rural India

Programme / Framework	Objective	Key Targets / Features	Relevance for Green Growth	Budget Allocation
Viksit Bharat–Guarantee for Rozgar and Aajeevika Mission (VB-G RAM G)	Promote rural livelihoods through natural resource management (NRM)	≥60% expenditure on agriculture and allied activities; ~102 million tonnes CO ₂ sequestered (2017–18) through plantations and soil improvement	Supports climate mitigation, water conservation, and land restoration while generating rural employment	Rs 86,000 crore (BE 2025–26); Rs 95,692 crore for VB G RAM G (BE 2026–27)
Jal Jeevan Mission (JJM)	Ensure universal rural drinking water with source sustainability	Household tap coverage increased from 17% (2019) to ~80% (2025); mandates rainwater harvesting, greywater management, and aquifer recharge	Strengthens long-term water security and integrates sustainability into service delivery	Rs 2,08,652 crore (Central outlay, 2019–2028)
Paramparagat Krishi Vikas Yojana (PKVY)	Promote organic farming through a cluster-based approach	End-to-end support for organic production, certification, and market linkage across clusters	Enables transition to sustainable agriculture with improved market access	Part of the National Food Security Mission; cluster-based grants
National Mission on Natural Farming (NMNF)	Scale natural, chemical-free farming systems	₹2,481 crore outlay; targets 1 crore farmers and 7.5 lakh hectares by 2030; promotes Jeevamrit, Beejamrit; establishes learning centres (PIB, MoA&FW, November 2024)	Enhances soil health, biodiversity, and farmer resilience through low-cost, sustainable practices	Rs 2,481 crore (2024–25 to 2025–26)
PM-KUSUM	Expand decentralized renewable energy in agriculture	Target of 34,800 MW by 2026; over 4.4 lakh solar pumps installed in 2024–25 (fourfold increase)	Reduces input costs, promotes clean energy use, and enables income from surplus power	Rs 2,600 crore (BE 2025–26)
Gobar-Dhan under Swachh Bharat Mission (Grameen) Phase II	Convert waste into energy and organic inputs	Functional biogas/CBG plants across 168 districts (2026); bio-slurry used in natural farming	Promotes circular economy, renewable energy, and soil nutrient recycling	Rs 10,000 crore (GOBARdhan, Union Budget 2023–24)
Gram Panchayat Development Plan (GPDP)	Enable integrated, decentralized village planning	Framework with 9 themes, including “Clean and Green Village.”	Facilitates convergence across water, energy, agriculture, and waste at the Gram Panchayat level	Funded through State Finance Commission & devolution grants

Source: Authors’ computation based on the Ministry of Rural Development (MoRD, 2013); Gol 2025; Ministry of New and Renewable Energy (MN&RE 2025); PRS Legislative Research 2023; Ministry of Jal Shakti 2026; and Ministry of Panchayati Raj (MoPr, 2021).

of climate change and environmental programmes in local administrations. These Green Fellows serve as an important link for implementing climate change and environmental projects by enabling the translation of state-level aspirations into a plan of action at the district level and in the villages; facilitating intra-departmental collaboration; and helping sustain an ongoing focus on sustainability in the face of normal administrative pressures. In addition to the Green Fellows, the Climate Resilient Villages programme, which was developed in collaboration with WRI India, has benefited 2.7 million people across 11 districts. The Climate Resilient Villages programme has installed solar photovoltaic systems on government buildings, restored canals to mitigate future flooding, installed water purification systems in schools, and offered jobs in the local communities to manage waste material (G.O.(Ms). No.50, Government of Tamil Nadu, 2022; and WRI, 2024).

Sikkim: Organic Transition as a National Landmark

Sikkim has become an exemplary case of a successful transition to organic agriculture as the first state in the world to be recognised as a fully organic state, a status achieved in January 2016. The development of a policy framework for Sikkim's transition occurred over a period of thirteen years, beginning in 2003 and culminating in a successful certification process for over 66,000 farming families on more than 76,000 hectares of land using certified organic methods of production and agroecological approaches.

The Sikkim experience provides an excellent example of how a vision for agricultural sustainability and an effective collaboration between multiple stakeholders can impact agricultural systems and

transform landscapes. In order to withdraw all chemical inputs from agriculture, Sikkim invested heavily in strategies such as farmer field schools, state-funded certification of organic production and establishing strategic linkages between farmers and markets. These actions resulted in Sikkim being awarded the United Nations' Future Policy Gold Award in 2018.

The transition to organic agriculture in Sikkim not only improved the life expectancy of its inhabitants but also created a viable and sustainable tourism industry, demonstrating the ability to combine ecological and economic goals in agriculture. The experience of Sikkim also has some important lessons for the National Mission on Natural Farming (NMNF) as it continues to grow and expand. During the early years of Sikkim's transition to organic agriculture there were significant reductions in income for farmers who were working to restore their soils and thus develop organic production systems.

The barriers for many farmers, particularly small and marginal farmers, in accessing new markets were a significant disadvantage during the early stages of the transition. The reason for the success of Sikkim during the transition the strong will and long-term vision. As natural farming spreads across diverse regions, these lessons will be pivotal in shaping its potential to become a transformative movement rather than facing challenges in implementation. (UNFAO/World Future Council, 2018).

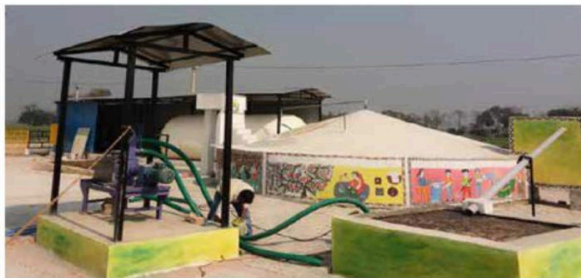
Gujarat: Solar Energy for Agriculture and Economic Development

The PM-KUSUM scheme in Gujarat demonstrates the potential of sustainability to improve farmer

livelihoods. The availability of solar water pumps has greatly decreased the reliance on unreliable electricity from the grid and/or expensive diesel generators. Through effective implementation of this program by the Gujarat Energy Development Agency, farmers in certain areas such as Banaskantha have already experienced significant economic advantages, including reduced monthly bills for agricultural electricity of more than ₹ 10,000/



Under the PM-KUSUM scheme, solar irrigation systems have allowed farmers to use clean energy for irrigation and earn additional income by selling surplus power to the grid



A community biogas plant under the Gobar-Dhan initiative converts agricultural waste into clean energy and organic manure, embodying circular-economy principles at the village level

month and generating new sources of income through the sale of surplus electricity produced by the purchase of a solar water pump. The success achieved through solar energy development in Gujarat demonstrates an important lesson, when sustainability is economically beneficial to farmers, they will quickly adopt sustainable technologies. Sustainability will no longer be seen as just an environmental goal but rather as a viable way for farmers to achieve their economic goals. (GEDA 2024).

Madhya Pradesh, Chhattisgarh, and Uttar Pradesh: Waste-to-Energy and Productive Villages

In Madhya Pradesh and Chhattisgarh, village waste can be practically converted to biogas (energy) and organic fertilizer from animal and organic waste through the Gobar-Dhan Initiative; this reduces farmers' fuel costs as well as their reliance on chemical fertilizers. Chhattisgarh has made significant progress in establishing community-based biogas plants; Uttar Pradesh has established community-based compressed biogas (CBG) plants. The use of these plants is generally much more consistent and sustained when Gram Panchayats assume responsibility for their operation than it is for plants that were built and left unused after the initial phase of construction. (Gol, 2026).

Opportunities and Strategies for Sustainable Progress Strengthening Core Enablers of Green Growth Implementation

Strengthening the foundations of sustainable development represents a core enabling condition throughout all of the aforementioned experiences; furthermore, there is clear evidence that the current

Government continues to place a consistent emphasis on strengthening these foundations. As such, the three types of interventions that create enduring change have been identified by strengthening local government institutions; convergence across schemes; and an integrated approach to behaviour change alongside infrastructure. Increasingly, all three enabling conditions will become embedded within the programme designs. For instance, without community

management, biogas plants revert back to being mere concrete structures, and without farmer participation the implementation efforts will not be effective.

Advancing Local Capacity and Outcome-Oriented Monitoring

Through the process of partnerships with the government and business, local capacity development and outcome-oriented monitoring will continue to be strengthened. The local government, or "Gram Panchayat", is the unit of planning for the "Clean and Green Village" objective, but has yet to develop the required levels of technical skill needed to plan for natural resource management (NRM) works, to understand and interpret water quality data, and to assess the feasibility of using solar or biogas.

To enhance this development, there are examples such as the Green Fellowships in Tamil Nadu, which are designed specifically to build the sector's capacity, whereby Green Planning will continue to be rewarded with financial returns and possibly move forward from procedural compliance. Concurrently, establishing and strengthening existing monitoring systems will continue to improve. While VB G RAM G expenditures are currently being recorded and accounted, there is an emerging awareness of the need to measure ecological outcomes such as the recharge of groundwater and the amount of carbon contained in organic soil.

With this in mind, the development of a low-cost, measurable impact at the local level, which will build upon the outputs and outcomes from MGNREGS, JJM, and SBM, represents an opportunity to strengthen the

local government's accountability through outcome-based governance.

Sustained Investments for Long-Term Environmental Gains

Long-term investment is key to effective management of natural resources. Efforts like watershed development, afforestation, and soil conservation have longer gestation periods and naturally take due time to show results, making consistent funding over several years crucial. There is now a growing focus on ensuring stability in funding, rather than short-term support. Strengthening multi-year planning will help communities fully benefit from the long-term environmental and economic gains of these efforts.

Strengthening Market Linkages for Green Rural Economies

Growing policy emphasis is placed on market linkages as an important means to enable a sustainable transformation of rural areas. Organic and natural production is fetching premium prices in urban markets, however, progress is being made to ensure that rural producers can access this value. Gobar-Dhan's bio-slurry is also an important organic input, but requires strong market development to establish regular demand for it. Providing a potential source of income through the sale of grid-connected generated electricity, under PM-KUSUM, creates new opportunities, but only if power purchase agreements are reliably implemented by DISCOMs. Addressing these issues is increasingly seen as a key requirement to move from scheme-based delivery to sustainable income generation.

Scaling Rural Green Growth: Based on National Achievements

India has already shown that ambitious green objectives can be met with strong commitment to policy and effective implementation. The country has met its 2030 NDC objective of 50% non-fossil electricity capacity ahead of time and recorded a non-fossil installed capacity of 51.93% in 2025. The next frontier will be using this success to drive the same results into the rural landscape in the six lakh villages across India so that they can become more sustainable, ecologically healthy, and economically resilient. (Gol 2026).

The Way Forward: Three Key Fundamentals to Strong Cooperation

The way forward comes down to three simple but important steps. First, the convergence must be institutionalised rather than relying upon individual administrator initiatives, which will have a positive effect on the overall success of the individual schemes/programmes. Second, local capacity should be viewed as a key aspect of investment in programme implementation. Some of the primary investments necessary to ensure effective implementation will involve training representatives to develop capacity for Green Planning at the local panchayat level, as well as providing trained technicians at the district level, as has been achieved in Tamil Nadu. Third, progress towards outcomes must be measured, monitored, and rewarded. Performance-based incentives should be provided that demonstrate improvement in the areas of water supply, soil health, energy transitioning, or waste management will help refocus local panchayats from merely utilizing inputs to demonstrating positive impacts.

Conclusion

The journey to transforming villages into vibrant green ecosystems is a gradual process unfolding through a series of thoughtful, incremental changes. These changes, for example, include regenerating natural water sources, encouraging farming communities to adopt natural farming practices, establishing biogas plants, and providing alternative cooking fuels that are renewable and clean. Together or independently, these initiatives connect and support the transformation of rural communities in India, not just to become recipients of green policies, but also to implement green initiatives and, more importantly, to lead in protecting the environment. The groundwork for this initiative already exists, exemplifying success in rural India, such as organic farming in Sikkim, climate-resilient villages in Tamil Nadu, and solar facilities in Gujarat.

What is critical now is the broadened dissemination of this knowledge into the daily lives of India's rural communities through efficient institutions, strategic planning, innovative markets, and continued assessment of progress. This combination will facilitate a sustainable and successful transition to greener rural environments. □

Harnessing Carbon Markets for Farmer's Prosperity in India



The global voluntary carbon market (VCM) has emerged as a significant mechanism for addressing climate change while creating new economic opportunities. This research based article examines the potential of the VCM to benefit Indian farmers by incentivising sustainable agricultural practices. With agriculture contributing substantially to greenhouse gas emissions, the adoption of climate-smart techniques such as Direct Seeded Rice (DSR), Alternate Wetting and Drying (AWD), and Agroforestry can reduce emissions while enhancing carbon sequestration. The study highlights global and Indian carbon market trends, key emission sources in agriculture, and internationally recognised verification standards. It further explores India's policy initiatives, including the Green Credit Programme, and outlines practical strategies for farmer participation. The findings suggest that integrating farmers into carbon markets can not only contribute to climate mitigation but also promote rural income generation, environmental sustainability, and the transition towards greener villages in India.

Deepika Sharma
Dr. Upendra Nath Roy



Across the globe, scientists and policymakers are actively working towards achieving sustainable development goals and ensuring environmental protection. In this context, a global carbon market has emerged rapidly over the past decade. According to a recent report by

Grand View Research, the global carbon credit market reached USD 887 billion in 2025 and is projected to reach at a compound annual growth rate (CAGR) of 25.9%, reaching USD 6,130 billion by 2033. In comparison, India's carbon credit market was valued at USD 4,010 million in 2023 and it is projected to reach USD 49,448 million by 2030 at a CAGR of 43.2%. The

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primary objective of this research paper is to examine the expanding role of the global carbon market and to identify strategies through which Indian farmers can derive potential economic benefits.

Agriculture forms a fundamental pillar of India's economy. The global population has now reached approximately 8.33 billion. To meet the food demands of this growing population, modern agricultural science embraced the Green Revolution.

Today, India's economy stands at a stage where agriculture is not merely a means of livelihood but a cornerstone of economic growth, rural stability, and food security. According to 2025–26 estimates, India ranks first globally in the production of pulses, milk, spices, jute, and millets, and second in the production of rice, wheat, fruits, vegetables, and sugarcane. These achievements have been made possible through the Green Revolution and the White Revolution. However, alongside these gains, pollution and carbon emissions in the agricultural sector have increased significantly.

At present, all countries share the critical responsibility of reducing carbon emissions to limit global temperature rise to below 1.5°C, as outlined in the Paris Agreement (2015). In this context, it has become essential to study the sources and processes of carbon emissions within agriculture.

Carbon Emissions in Agriculture and Their Major Components

According to the Food and Agriculture Organization (FAO), approximately 18% of global carbon emissions originate from the agricultural sector, making their reduction a matter of urgent importance. These emissions arise primarily from five key components:

1. **Livestock digestion (enteric fermentation):** Emissions from the digestive processes of domestic and wild ruminants account for nearly 53%, releasing methane and carbon dioxide.
2. **Use of chemical fertilisers:** This contributes approximately 21% of total emissions.
3. **Rice cultivation:** Paddy cultivation worldwide accounts for about 17% of emissions.
4. **Mismanagement of manure and biomass:** Poor handling of animal waste and biomass contributes around 6.5% of emissions.
5. **Burning of agricultural residues:** The burning of crop residues in fields contributes roughly 2% of emissions.

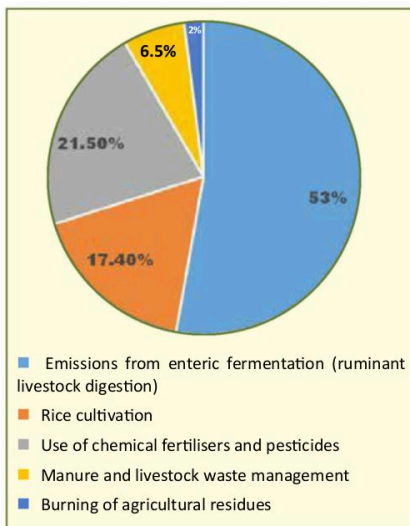


Figure 1: Major Sources of Carbon Emissions in Agriculture

To address the threat of climate change and regulate global temperatures, countries worldwide are implementing a range of clean and green development mechanisms.

Voluntary Carbon Market (VCM)

In response to the global climate crisis, numerous efforts are being undertaken worldwide, commonly referred to as *clean and green projects*. At the international level, the compliance market includes mechanisms such as the Kyoto Protocol (1997), which introduced the Clean Development Mechanism (CDM).

At present, several developed countries and corporate entities are promoting these clean and green initiatives by providing funding or grants. In return, they receive carbon credits. This process has led to the emergence of a global *Voluntary Carbon Market (VCM)*.

According to a report by Grand View Research, the global carbon credit market reached USD 887 billion in 2025 and is projected to grow to USD 6,130 billion by 2033, at a compound annual growth rate (CAGR) of 25.9% between 2026 and 2033. In comparison, India's carbon credit market was valued at USD 4,010 million in 2023 and is expected to reach USD 49,448 million by 2030, growing at a CAGR of 43.2%.

These carbon credits are also crucial for supporting national efforts to achieve the targets set under the Paris Agreement. The voluntary carbon market provides a flexible market mechanism for corporations to offset their emissions by investing in sustainability-oriented projects. In addition, it generates co-benefits such as improved livelihoods, supports clean and green development, and encourages innovation.

Government of India Initiatives

The Ministry of Environment, Forest and Climate Change, Government of India, has developed a framework for the *Green Credit Programme*. Under this initiative, a market-based mechanism has been established to promote activities such as tree plantation on degraded land, where “Green Credits” (GCs) are issued for environmentally positive actions.

It is well recognised that practices such as afforestation (including plantation of fruit-bearing trees), regenerative agriculture, and zero tillage contribute to carbon sequestration in soil. Voluntary carbon markets can play a significant role in financing such climate solutions.

However, the success of the voluntary carbon market depends on the presence of clear and robust regulatory frameworks to ensure genuine emission reductions. Equally important is the need to educate farmers and other stakeholders about these mechanisms and their benefits.

What is a Carbon Credit?

A carbon credit is a certification that represents the removal, reduction, or avoidance of one metric tonne of carbon dioxide (or its equivalent in other greenhouse gases) from the atmosphere.

Carbon Credit = 1 metric tonne of CO₂ equivalent (tCO₂e) reduced, avoided, or removed

Carbon credits present a significant opportunity to strengthen India’s rural economy, as they incentivise farmers to adopt practices such as natural farming, agroforestry, and improved biomass management that reduce emissions or enhance carbon sequestration in soil.

Such approaches not only improve soil health and promote water conservation but also contribute to mitigating global temperature rise and generating green employment opportunities.

Currently, there is strong demand for carbon credits in developed countries, particularly among corporate sectors. In recent years, major buyers of carbon credits have included the United States, China, Japan, and the United Kingdom.

Global Standards for Carbon Offset Projects

At present, *Verra* and the *Gold Standard* are among the leading global standards for the verification of carbon offset projects.

1. Verra (Verified Carbon Standard – VCS)

The Verified Carbon Standard (VCS) is administered by Verra, an organisation based in Washington, D.C., USA. It is one of the most widely used global standards, focusing on the reduction and removal of greenhouse gas emissions through a diverse range of project types.

These include projects in renewable energy, forestry (including REDD+), biochar, and waste management. Verra is the largest voluntary carbon market standard in terms of volume and is widely recognised at the international level.

2. Gold Standard

The Gold Standard is a premium certification framework that places strong emphasis not only on climate impact but also on sustainable development co-benefits, particularly alignment with the Sustainable Development Goals (SDGs).

Projects under this standard require a higher level of stakeholder engagement, monitoring, and verification. Due to its rigorous processes and high credibility, Gold Standard-certified credits often command higher prices in the market.

Studies on international carbon credit trading indicate that voluntary carbon markets can play a crucial role in linking climate action with agricultural communities in developing countries such as India. In particular, they hold significant potential to integrate Indian farmers into global climate mitigation efforts.

Strategies for Reducing Carbon Emissions

1. Reducing Carbon Emissions in Rice Cultivation

Direct Seeded Rice (DSR) : Direct Seeded Rice (DSR) is a cultivation method in which rice seeds are sown directly into the field, eliminating the need for nursery raising and transplanting. This approach saves time, labour, and water, making it a more cost-effective and modern alternative to traditional transplanting

methods. Sowing can be carried out either manually or using seed drills.

In this method, pre-germinated seeds are directly sown in the field approximately 20–30 days earlier than the conventional transplanting schedule, often using tractor-operated machinery. Compared to traditional practices, DSR can reduce water usage by approximately 15–20%.

Under conventional rice production systems, approximately 1,500 to 2,000 litres of water are required to produce one kilogram of rice. Typically, rice cultivation in India requires 25–27 irrigation cycles; however, with DSR, this can be reduced to around 15–18 irrigations.

In addition to water savings, DSR reduces labour requirements and enables the crop to mature 7–10 days earlier. This provides farmers with additional time for effective management of rice straw residues.

Alternate Wetting and Drying (AWD) : Alternate Wetting and Drying (AWD) is an advanced irrigation management technique in which fields are not kept continuously flooded. Instead, irrigation is applied only after the water level has receded to a certain threshold.

This method significantly reduces water consumption compared to conventional flooding practices and, importantly, lowers methane emissions from paddy fields. In recent years, AWD has been widely promoted across Asia and has been extensively adopted in countries such as China, the Philippines, and several Southeast Asian nations.

Over the past decade, millions of smallholder farmers in Maharashtra have actively adopted AWD to address water scarcity challenges, demonstrating its practical relevance in Indian conditions.

2. Agroforestry

Agroforestry refers to the integration of trees with agricultural crops, often in the form of row-based cropping systems where crops are cultivated between rows of trees. This approach offers multiple ecological and economic benefits.

Agroforestry plays a vital role in improving soil health, enhancing biodiversity, and conserving land resources. It promotes local biodiversity and reduces pressure on natural forests by providing alternative sources of fodder and fuelwood.

Through photosynthesis, agroforestry systems increase oxygen levels in the atmosphere while simultaneously enhancing carbon sequestration in the soil. As a result, such projects enable farmers to earn carbon credits.

A study conducted in the northern plains of India found that poplar-based agroforestry systems across seven districts in Punjab and Haryana stored approximately 9.946 million tonnes of CO₂ equivalent. In Yamunanagar district alone, carbon storage was estimated at 3.026 million tonnes, highlighting the significant carbon sequestration potential of these systems.

Furthermore, agroforestry models involving species such as eucalyptus and poplar can generate additional income of up to ₹25,000 per hectare per year for farmers. Similarly, forests across the country also exhibit high carbon storage capacity.

Overall, agroforestry presents substantial potential across all regions of India as a sustainable climate-smart agricultural practice.

Conclusion and Recommendations

The global voluntary carbon market presents a significant opportunity for Indian farmers to enhance their incomes while contributing to climate change mitigation. However, to effectively participate in this market, farmers need to organise themselves collectively through Farmer Producer Organisations (FPOs), cooperatives, or government-supported institutions. Such collective approaches are essential for registering agricultural land and farming practices in accordance with international standards.

Once registered, farmers can actively participate by adopting sustainable agricultural practices. These include agroforestry, organic farming, and climate-smart rice cultivation techniques such as Direct Seeded Rice (DSR) and Alternate Wetting and Drying (AWD). In addition, improved livestock feed management, utilisation of renewable energy sources such as solar energy and biogas, efficient manure management, and proper handling of crop residues (including stubble management) can be incorporated as carbon offset projects.

Adoption of these practices will not only promote sustainable agriculture but also enable farmers to receive financial incentives in the form of carbon credits, aligned with international market standards. Moreover, lower methane emission helps in reducing pollution. □

Livelihoods, Green Economy and Rural Enterprises

Building the Foundations of *Viksit Bharat*

Rural India lies at the heart of India's transition towards a green and inclusive development model. As the country advances towards the vision of *Viksit Bharat*, livelihoods are increasingly being reshaped through sustainable agriculture, renewable energy, circular economy practices, and rural entrepreneurship. Government initiatives such as DAY-NRLM, PM-KUSUM, GOBARDhan, and natural farming missions are integrating economic growth with ecological balance and social inclusion. At the same time, Self Help Groups, farmer collectives, and village enterprises are emerging as key drivers of this transformation. This article examines how rural livelihoods are evolving within the framework of the green economy and becoming central to India's sustainable development journey.

Dr. Ritu Saraswat

India's development story has always been rooted in its villages. Even today, with nearly 65 percent of the total population residing in rural areas, a significant share of livelihoods continues to depend on agriculture and allied activities. This demographic reality makes rural India not merely

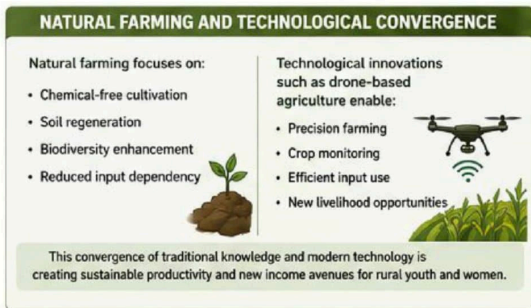
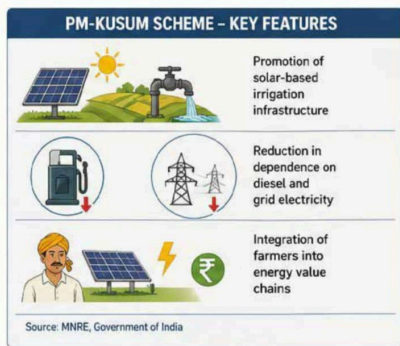
a recipient of development policy but its central driver. At the same time, India's rapid economic expansion has brought visible environmental stress, ranging from groundwater depletion and soil degradation to rising emissions and waste generation. The challenge, therefore, is no longer whether growth should continue, but how it can be aligned with ecological sustainability.

It is in this context that the idea of a green economy has gained policy prominence globally and in India. As defined by the United Nations Environment Programme (UNEP), a green economy is “low carbon, resource efficient and socially inclusive,” designed to improve human well-being while reducing environmental risks and ecological scarcities. India’s evolving development strategy increasingly reflects this framework, particularly through rural transformation, renewable energy expansion, and livelihood diversification.

The Green Economy Framework

The concept of the green economy first gained structured attention through David Pearce’s *Blueprint for a Green Economy* (1989), but it has since evolved into a core pillar of sustainable development within UN frameworks and national policies. In India, this transition is reflected in multi-sectoral policy convergence:

- Ministry of Environment, Forest and Climate Change (MoEFCC) initiatives on climate action and circular economy
- Ministry of New and Renewable Energy (MNRE) programmes such as PM-KUSUM
- NITI Aayog strategies on resource efficiency and waste-to-wealth systems
- NABARD interventions in rural credit, FPOs, and green financing



- Ministry of Rural Development (MoRD) schemes like DAY-NRLM and MGNREGS (now being restructured and referred to as VB-G RAM G, with a stronger focus on asset creation, climate resilience, and sustainable rural infrastructure). VB-G RAM G aims to move beyond wage employment towards durable rural asset creation, natural resource management, and climate-adaptive livelihood support systems. While MGNREGS primarily focused on providing wage employment and short-term livelihood security, VB-G RAM G represents a strategic shift towards long-term rural asset creation, productivity enhancement, and climate-resilient development outcomes.

According to NITI Aayog (2023), India’s circular economy alone could generate millions of jobs and unlock significant material recovery value if properly integrated with rural systems. The green economy is now understood not as a standalone environmental agenda but as a development model integrating economy, society, and ecology.

From Welfare Model to Enterprise Ecosystem

A major structural shift underway in rural India is the transition from a welfare-based model to an enterprise-driven livelihood system.

DAY-NRLM and Institutional Transformation: The Deendayal Antyodaya Yojana—National Rural Livelihoods Mission (DAY-NRLM), launched by the MoRD, Government of India, represents one of the largest community institution-building programmes globally. Its core architecture—Self Help Groups (SHGs)—has fundamentally reshaped rural financial inclusion. According to NABARD’s SHG-Bank Linkage Programme reports, millions of rural women now access formal credit channels, reducing dependence on informal lenders.

PANCHAYATI RAJ INSTITUTIONS INSTITUTIONAL BACKBONE OF THE GREEN RURAL TRANSITION

Gram Panchayats occupy a central position in India's rural governance architecture and are emerging as critical institutions for enabling the green economy at the grassroots level. As the closest tier of governance, they act as convergence platforms for rural development schemes and local planning processes. Their role extends to integrated functions such as planning and convergence of programmes like DAY-NRLM, MGNREGS, SBM-Grameen, PM-KUSUM, and GOBARdhan; local management of natural resources including water conservation, soil health, and commons; supervision of waste and sanitation systems under circular economy models; and facilitation of Self Help Groups (SHGs), Farmer Producer Organisations (FPOs), and village enterprises.

In several regions, Panchayats have demonstrated strong leadership in driving sustainable development

outcomes. For instance, in Maharashtra's Hiware Bazar Gram Panchayat, participatory watershed management and water conservation planning transformed a drought-prone village into a model of water sufficiency and rural prosperity. Similarly, Piplantri Gram Panchayat in Rajasthan has gained recognition for integrating environmental conservation with social development through large-scale tree plantation linked to girl child welfare, strengthening ecological balance and community participation.

These examples highlight how empowered Panchayats can translate policy intent into measurable ground-level outcomes. In the context of the green transition, Gram Panchayats function as the institutional bridge between national policy frameworks and grassroots implementation, making them indispensable to building sustainable and climate-resilient rural India.

More importantly, SHGs have evolved beyond savings groups into producer collectives, micro-enterprises, and service providers, engaging in dairy and livestock value chains, food processing, tailoring, handicrafts, retail, and local services. This transformation reflects a shift from survival-based livelihoods to institutionally supported rural entrepreneurship ecosystems.

Building Village-Level Enterprises: The Startup Village Entrepreneurship Programme (SVEP) under DAY-NRLM marks a critical evolution in rural development strategy. Unlike subsidy-led models, SVEP focuses on business planning support, enterprise incubation, access to credit, mentoring, and capacity building. This has led to the emergence of micro-enterprises in services, agro-processing, repair work, and small manufacturing, thereby reducing distress migration and strengthening local economies. As highlighted in MoRD policy briefs, rural entrepreneurship is increasingly viewed as a tool for employment generation and local value creation.

Linking Economy with Ecology

The green economy becomes most tangible in rural India through its linkage with livelihoods.

Sustainable agriculture: Programmes like *Paramparagat Krishi Vikas Yojana* and the National

Mission on Natural Farming (NMNF) promote reduced chemical inputs, soil regeneration, organic farming clusters, and climate-resilient practices. Studies referenced by the Food and Land Use Coalition (FOLU India) show that sustainable agriculture remains limited in scale but has strong potential for expansion if supported by robust market linkages and institutional backing.

Renewable Energy and Rural Energy Transition : The PM-KUSUM scheme (MNRE, Government of India) is transforming rural energy systems by promoting solar irrigation pumps, decentralised renewable generation, and enhancing farmer income through surplus electricity sales. According to MNRE updates, India has already achieved significant renewable capacity expansion, positioning rural areas as active contributors to the country's energy transition.

Waste to Wealth and Circular Economy: Initiatives like GOBARdhan (Galvanising Organic Bio-Agro Resources Dhan) under Swachh Bharat Mission (SBM-Grameen Phase II) promote biogas generation, organic fertiliser production, and circular waste systems. MoEFCC's circular economy framework (2021 onwards) further supports the integration of waste management with rural livelihoods, creating both environmental and economic value at the grassroots level.

Gender and Green Economy: An Underutilised Force Multiplier

One of the most transformative but under-recognised dimensions of rural green growth is women's participation. According to World Bank and ILO estimates, increasing women's workforce participation could significantly boost India's GDP, with some projections suggesting gains of up to USD 700+ billion in the medium term.

In rural India, SHGs are largely women-led and are actively engaged in agro-processing and enterprise development. Moreover, renewable energy programmes like Surya Mitra (MNRE) are training women in solar technology. Initiatives such as "Drone Didi" further demonstrate how women are entering high-tech agriculture and precision farming.

Despite this progress, women still constitute a relatively small share of formal enterprises (as per government MSME data). This indicates that the green economy is not only an environmental transition but also a gender inclusion opportunity of macro-economic scale.

Natural Farming and Technological Transition

India's shift towards natural farming reflects a hybrid model combining traditional knowledge and modern science. Natural farming reduces input costs, improves soil organic content, enhances water retention, and strengthens climate resilience.

Simultaneously, initiatives like "Drone Didi" demonstrate how rural women are entering precision agriculture through drone technology for crop monitoring, spraying, and yield optimisation. This convergence of ecology, technology, and gender empowerment is redefining rural productivity systems.

Key Challenges: Why the Transition Is Still Uneven

Despite policy momentum, the green rural economy faces several structural constraints:

- Fragmented implementation across states
- Limited access to market linkages for green products
- Knowledge gaps at the grassroots level
- Weak integration between schemes
- Inadequate climate finance penetration in rural areas

As noted in NITI Aayog and World Bank reports, institutional convergence remains the most critical missing link in scaling impact.

GENDER DIMENSIONS OF THE GREEN ECONOMY

Women are key drivers of rural green transformation through SHGs and related initiatives.

-  Renewable energy enterprises
-  Organic input production
-  Agro-processing units
-  Recycling and waste management activities

Programmes such as Surya Mitra (MNRE) are enabling technical skilling in solar energy systems. However, greater institutional support and market integration are needed to enhance women's participation in formal enterprises.



From Schemes to Systems

The future of India's rural green economy depends on three structural shifts:

- **Institutional convergence:** Schemes such as DAY-NRLM, MGNREGS, PM-KUSUM, and SBM must operate as an integrated ecosystem rather than isolated programmes.
- **Capacity building:** Gram Panchayats must evolve into local climate and enterprise planning units, supported by technical training and digital tools.
- **Market integration:** Without stable markets for organic produce, renewable energy, and circular products, rural green enterprises cannot scale sustainably.

Conclusion: Towards a Green and Inclusive Rural Future

India's transition towards a green economy is no longer aspirational; it is actively unfolding across its rural landscape. However, its success depends on whether rural India can be transformed from a passive beneficiary into an active architect of sustainability. From SHGs and solar pumps to natural farming and circular waste systems, rural India is gradually building the foundations of a *Viksit Bharat* rooted in ecological balance and inclusive growth. The next phase of transformation will depend on scaling integrated systems, strengthening local institutions, and ensuring reliable market linkages. If these elements align, India's villages will not only sustain the green economy, they will lead and define its future trajectory. □



Community-led Water Management

Water lies at the heart of India's journey towards sustainable and inclusive green growth. As pressures from climate change, rising demand, and ageing infrastructure intensify, conventional top-down approaches to water management are proving insufficient. Community-led water governance, rooted in local institutions such as Panchayati Raj Institutions and Water Users Associations, offers a more resilient and equitable alternative. By integrating traditional knowledge with modern practices, and linking water with energy, livelihoods, and ecosystem sustainability, such approaches can enhance efficiency, reduce resource stress, and ensure long-term water security. Strengthening these local systems is essential for building a climate-resilient and resource-efficient future.

Arunlal K.



Green growth is about developing the economy while carefully managing natural resources, with water playing a vital role at the local level. Strong local institutions such as Panchayati Raj Institutions (PRIs), along with active community participation, make water management more efficient, equitable, and resilient. By linking water with climate

action, energy use, and inclusive governance, long-term sustainability and reliable resource security can be ensured.

Green growth refers to promoting economic development while ensuring that natural resources continue to provide the materials and environmental services essential for human well-being. Key natural

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resources, such as water, are best managed at the grassroots level. A village-level community comprising all stakeholders including government authorities, primary beneficiaries, and those with competing demands forms an ideal unit for effective water management.

In India, there are approximately six lakh inhabited villages, accommodating around 95 to 100 crore people. With the empowerment of Panchayati Raj Institutions through the 73rd Amendment of the Constitution, villages have become effective administrative units. As a result, the voices of villagers have had a positive impact on governance. Furthermore, subjects such as minor irrigation, water management, watershed development, and drinking water are included in the Eleventh Schedule of the Constitution, which outlines the responsibilities of PRIs.

Essential Elements of Green Growth

According to the Organisation for Economic Co-operation and Development (OECD), an international forum of 38 member countries committed to democracy and market economies in which India is a key partner a green growth strategy focuses on aligning economic and environmental policies so that they reinforce each other. It recognises the full value of natural resources as essential to production and growth. It also emphasises cost-effective methods to reduce environmental pressures, enabling a transition towards new growth patterns that avoid exceeding critical environmental limits at local, regional, and global levels.

This concept is also endorsed by the United Nations. The green growth pathway includes increased productivity through the optimal use of resources; innovative approaches to addressing environmental challenges; stimulation of demand for green technologies and practices; appropriate pricing of pollution; and the reduction of resource bottlenecks and imbalances in natural systems. It is also linked to the Nationally Determined Contribution (NDC 3.0). Integration of the water sector within NDC 3.0 focuses on sustainable resource management, resilient infrastructure, and low-carbon WASH (Water, Sanitation, and Hygiene) systems to address rising water scarcity and climate-related risks.

Support from Finance Commissions

The Thirteenth Finance Commission (2010-15) observed that international experience demonstrates that green growth promotes inclusivity. It further noted

that environmental degradation reduces the quality of life for all citizens, with particularly severe impacts on poor and vulnerable groups, who are most affected by limited access to clean water, air, and sanitation.

It is, therefore, important to incentivise fiscal policies that promote energy conservation, renewable energy, soil conservation, afforestation, and improved access to clean water at all levels of government. Subsequent Finance Commissions have also extended strong support for water conservation and efforts to ensure water security in rural areas.

The Fifteenth Finance Commission (2021-26) earmarked 60 per cent of total grants allocated to Panchayati Raj Institutions for national priorities such as drinking water supply, rainwater harvesting, and sanitation. The Sixteenth Finance Commission (2026-31), recognising the importance of improving citizens' quality of life and reaffirming commitment to achieving Sustainable Development Goal 6 (Clean Water and Sanitation), has also recommended that 50 per cent of the basic component allocated to local bodies be directed towards 'Sanitation and Solid Waste Management' and/or 'Water Management'.

Water at the Centre

Water resource management plays a vital role in achieving green growth from multiple perspectives. It encompasses the use of water for agriculture, industry (including cooling), drinking, sanitation, energy generation, and recreation. It also requires attention to watershed services, not merely water supply and sanitation. Inadequate investment in infrastructure, regulation, monitoring, and information systems can restrict access to quality water services and hinder economic growth. When managed effectively, however, water resources can support growth while placing minimal strain on natural systems.

Ageing water infrastructure has emerged as a significant concern. For instance, there are 5,264 completed dams in the country, with an additional 437 under construction. Of these, 3,701 dams, approximately 73 per cent of completed dams, were constructed before 1990. Among the 65 dams of national importance, 31 are at least 45 years old. Analysis conducted by the Central Water Commission under the Ministry of Jal Shakti indicates that around 0.73 per cent of reservoir storage capacity is lost annually due to silt accumulation, resulting in a cumulative loss of nearly 30 per cent.

The impact of siltation is not limited to large reservoirs; ponds and tanks also suffer capacity loss due to the accumulation of clay and silt. This issue can be effectively addressed through proper watershed management in reservoir catchment areas, along with regular desilting of ponds and tanks, activities in which rural communities can play a significant role.

A major cause of reservoir sedimentation is uncontrolled soil erosion in catchment areas. Micro-level watershed interventions offer an ideal solution and can be more effectively planned, implemented, and maintained by local communities. Measures such as afforestation and reforestation of catchment areas, planting vegetative barriers, contour bunding of farmlands, construction of temporary structures like gully plugs across drainage lines, and the selection of crops that minimise soil erosion can significantly reduce runoff and sediment inflow.

Regular rejuvenation of ponds and tanks through the removal of deposited silt and clay is another effective strategy for sustaining water storage in rural areas. The excavated material, being rich in nutrients, can be used as manure for agricultural fields. This approach has been successfully implemented under the *Mission Amrit Sarovar*, where approximately 70,000 ponds have been rejuvenated, and it holds strong potential for further scaling. According to the Water Body Census conducted by the Ministry of Jal Shakti, India has around 14.43 lakh ponds.

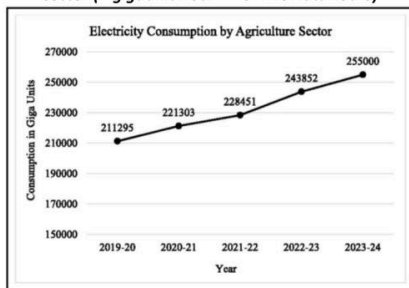
Water-Energy Nexus

Subsidised electricity has played a crucial role in increasing groundwater abstraction. However, reducing these subsidies presents challenges, particularly in the context of food security. Data from the Central Ground Water Board indicates that 14.18 per cent of groundwater assessment units fall into either the 'over-exploited' category (where extraction exceeds annual recharge) or the 'critical' category (where extraction is between 90 and 100 per cent of recharge).

Electricity consumption in the agricultural sector is also rising steadily. Between 2019-20 and 2023-24, consumption increased by 20.68 per cent.

Community involvement can help curb this trend by promoting more sustainable practices, including the judicious use of groundwater and the solarisation of irrigation pumps. Savings from reduced power

Figure 1: Electricity consumption by the agricultural sector (1 gigaunit-hour = 10⁶ kilowatt-hours)



source: *Energy Statistics India 2025, Ministry of Statistics and Programme Implementation*

subsidies without imposing additional financial burdens on farmers can be redirected towards more productive uses.

Schemes such as PM-KUSUM support the solarisation of pumps for individual farmers, as well as the establishment of solar plants of up to 2 MW capacity by Farmer Producer Organisations (FPOs) and Water Users Associations (WUAs). Farmers can also monetise surplus solar power by selling it to distribution companies (DISCOMs), thereby creating an additional source of income.

Minor Irrigation Schemes

Schemes catering to irrigation requirements for areas up to 2,000 hectares are classified as Minor Irrigation (MI) Schemes. According to the Sixth Minor Irrigation Census (reference year 2017-18; data from the Seventh Census for the entire country is yet to be released), there are 23.14 million MI schemes across India, with an irrigation potential of 75.64 million hectares nearly half of the country's total irrigation potential.

Notably and somewhat alarmingly 94.7 per cent of these schemes (21.93 million out of 23.14 million) are groundwater-based. There has also been a significant increase in the number of deep and medium tubewells. Given their relatively small scale, MI schemes are particularly well-suited for community-based management. There is considerable scope for improving irrigation efficiency by reducing conveyance losses and adopting more efficient irrigation methods.

Water Users Associations (WUAs) can be established for every 40 to 50 hectares, supported by an advisory committee at the project level comprising representatives from WUAs, government officials, and elected representatives. Such an institutional framework can promote harmony in water conservation by fostering a sense of ownership and enabling democratic decision-making. The water and energy conserved through these measures are valuable assets in building a greener future.

Managing Conflicting Demands

Water resources are shared among multiple stakeholders with often competing demands. For instance, a reservoir may serve rural farmers, supply raw water for urban drinking needs, and support industrial use. The release of water for irrigation during summer may benefit farmers but raise concerns among urban populations dependent on drinking water supply.

During drought years, both agricultural and domestic users may oppose allocations for industrial purposes, even though industries provide livelihoods for a significant number of workers. Curtailing industrial water supply, in turn, can disrupt local economic stability. In such situations, community-level management can play a crucial role in building consensus, as opposed to relying solely on top-down administrative decisions.

Another important aspect that community-driven approaches can better address is the protection of riparian rights of downstream communities and the maintenance of environmental flows in rivers both of which are essential for sustainable and green growth. There have been instances where upstream dam construction has led to the near-complete drying of rivers downstream, causing irreversible damage to biodiversity.

Sustainable Operation and Maintenance

A major challenge faced by almost all water infrastructure systems is deferred maintenance. Achieving self-sufficiency in operation and maintenance (O&M) can significantly improve the performance and extend the useful life of such systems. However, inadequate maintenance funding often results in frequent breakdowns and, in some cases, the eventual abandonment of schemes.

Introducing a system of reasonable and affordable user charges sufficient to meet O&M expenses—can be effectively implemented through the collective responsibility of beneficiary communities. Such community-led arrangements may also be supported by government grants. Several states have already introduced enabling legislation in this regard. For example, the Kerala Irrigation and Water Conservation Act, 2003 authorises Water Users Associations (WUAs) to levy and collect fees, and entrusts them with the responsibility of maintaining and managing designated parts of the water distribution system.

Traditional knowledge possessed by local communities can also play a valuable role in managing infrastructure and carrying out maintenance in a cost-effective manner. Their involvement can help reduce overhead expenses, such as the cost of land for storing construction materials, creating access routes to infrastructure, and hiring external labour.

Way Forward

Going forward, community-led water management needs to be institutionalised and streamlined through sustained capacity building. Training and awareness programmes on the planning, implementation, and management of water infrastructure and government schemes should be provided to community members to ensure that their participation is both productive and meaningful.

Women, as primary users, managers, and stewards of water at the household level, should be adequately represented in leadership roles within water user communities. Ensuring their participation in decision-making processes is essential for inclusive and effective governance.

Furthermore, community collectives must be financially empowered to undertake regular operation and maintenance of water utility systems. This will enhance the performance and longevity of infrastructure, thereby improving regional water security and contributing to energy savings.

In addition, the efficient use of water in agriculture and industry will enhance productivity while ensuring optimal utilisation of resources. Such measures will align development activities with green growth principles by ensuring sustainable resource availability and equitable access for all. □



Green Technology Driving India's Renewable Revolution

India's energy landscape has undergone a remarkable transformation over the past fifteen years, driven by rapid advancements in green technology and a strong push towards renewable energy. This progress highlights how innovation in solar, wind and other clean energy sources is not only reducing carbon emissions but also reshaping rural livelihoods and strengthening energy security. From expanding electricity access in remote villages to emerging as a global leader in renewable capacity, India's journey reflects the growing role of technology in building a sustainable and inclusive future.

I Villages once dependent on kerosene lamps are now powered by solar energy and connected through digital infrastructure, making renewable energy a cornerstone of India's development story. This transformation goes beyond merely adding megawatts of clean power. It represents the deeper integration of green technology solutions that reduce environmental impact while enhancing efficiency and accessibility into everyday life. Solar panels, wind turbines, bio-energy systems and smart grids are no longer abstract concepts; they are actively reshaping rural India and steering the country towards a more sustainable future.

Transformation in Energy: A Quiet Revolution

In 2010, India's renewable energy capacity stood at roughly 17 gigawatts, with fossil fuels dominating the energy mix. Over the next fifteen years, a combination of policy support, technological advancement, and falling costs led to an unprecedented expansion. By 2026, renewable energy capacity has crossed approximately 270 gigawatts, marking more than a fifteen-fold increase.

Solar energy has emerged as the driving force behind this transition. From a modest base, it has grown into the largest component of India's renewable portfolio, supported by large solar parks, rooftop

installations, and decentralised systems. Wind energy has complemented this growth, particularly in states such as Tamil Nadu and Gujarat, providing stability and diversity to the renewable mix.

This shift highlights the success of green technology in making clean energy both viable and affordable. With solar tariffs among the lowest globally, India demonstrates how innovation can align economic growth with environmental sustainability.

The most profound impact of renewable energy has been felt in rural India. Decentralised solutions such as solar mini-grids, rooftop systems, and solar-powered irrigation have brought reliable electricity to previously underserved regions.

A notable example is the **Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan (PM-KUSUM)**, which enables farmers to use solar pumps for irrigation. This reduces dependence on diesel, lowers costs, and allows farmers to generate additional income by selling surplus electricity. The scheme has also contributed significantly to reducing carbon emissions and fuel consumption.

Similarly, the **Saubhagya Scheme** has expanded electricity access, with renewable solutions playing a crucial role in remote areas. These interventions have improved education, healthcare, and rural entrepreneurship, demonstrating how green technology acts as a catalyst for inclusive development.

Changing the Energy Mix and Reducing Emissions

India's energy profile is undergoing a structural shift. Nearly 40 per cent of installed power capacity now comes

from non-fossil sources, and renewable energy continues to dominate new capacity additions. This transition has tangible environmental benefits. Renewable sources such as solar and wind produce no direct carbon emissions, reducing the overall carbon intensity of electricity generation. In recent years, renewable growth has even contributed to a slowdown in fossil fuel-based power expansion.

India has already achieved the milestone of 50 per cent of its installed capacity from non-fossil sources ahead of its 2030 target, reflecting its commitment to global climate goals. The long-term objective of reaching 500 gigawatts of non-fossil capacity further reinforces this trajectory towards a low-carbon economy.

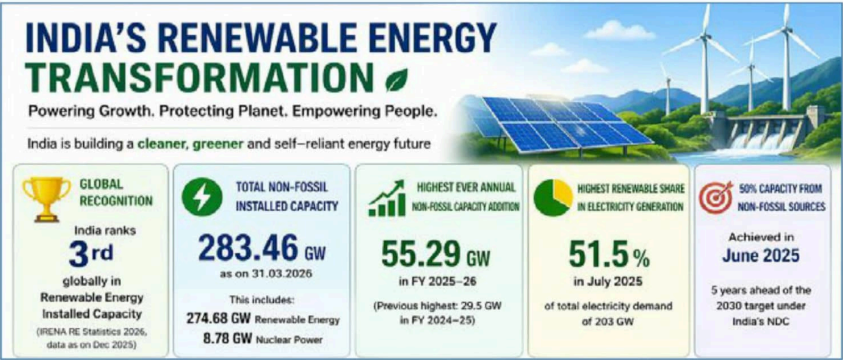
Economic and Strategic Dimensions

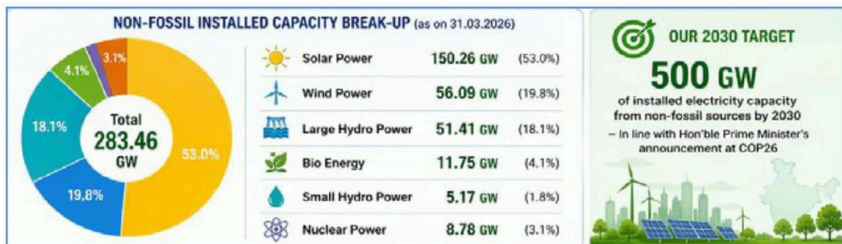
The renewable energy sector has become a key driver of economic growth and energy security. Falling costs have made clean energy competitive, attracting large-scale investments and encouraging industrial adoption.

India is also strengthening its domestic manufacturing ecosystem. Solar module production capacity and wind turbine manufacturing have expanded significantly, reducing reliance on imports and supporting the vision of self-reliance. This transition positions India as a potential global hub for renewable energy technology.

Policy and Institutional Support enabling Green Technology

The rapid growth of renewable energy in India has been strongly supported by proactive policy measures led by the **Ministry of New and Renewable Energy**. Recent initiatives have focused on making green





technology more affordable and accessible. For instance, the reduction in GST on renewable energy equipment has lowered costs for developers and consumers alike.

Efforts to promote domestic manufacturing, including incentives for battery production, are strengthening India's position in emerging sectors such as energy storage. Regulatory reforms—ranging from improved transmission access to simplified compliance frameworks—have enhanced efficiency and encouraged investment.

Innovative mechanisms such as Virtual Power Purchase Agreements and Contracts for Difference are providing financial stability to developers, while the introduction of a National Policy on Geothermal Energy signals diversification beyond traditional renewable sources. Together, these measures create a robust ecosystem for sustained growth.

Recent Progress and Achievements

These policy interventions have translated into tangible progress on the ground, particularly in the past year. India achieved record-breaking growth in renewable energy during 2025–26, with solar capacity surpassing 150 GW and registering the highest-ever annual addition of over 44 GW.

A significant share of this growth has come from decentralised solar systems, including rooftop installations and PM-KUSUM projects, benefiting millions of households and farmers. Wind energy also recorded its highest-ever annual addition, further strengthening India's renewable portfolio.

Emerging sectors are gaining momentum as well. The **National Green Hydrogen Mission** has made notable progress, with falling production costs and increasing industrial adoption. This positions India as a potential global leader in green hydrogen, particularly for sectors that are difficult to decarbonise.

Infrastructure development has kept pace with generation growth. Initiatives such as the Green Energy Corridor have strengthened transmission networks, enabling efficient integration of renewable power into the grid.

At the same time, investments in research, innovation, and skill development are ensuring long-term sustainability. Advances in solar technology, battery storage, and workforce training are building a strong foundation for the future of green energy in India.

A Success Story Rooted in Policy and Innovation

India's renewable energy success is rooted in the synergy between policy and technology. Programmes implemented by the **Ministry of New and Renewable Energy**, along with grassroots initiatives, have ensured that the benefits of clean energy reach even the most remote regions.

In states such as Rajasthan, solar-powered irrigation has enabled farmers to increase productivity and income while reducing environmental impact. Such examples highlight how green technology, when effectively implemented, can deliver both economic and ecological benefits.

Technology for a Sustainable Tomorrow

As National Technology Day is observed, India's renewable energy journey offers a powerful lesson in the role of technology in shaping a sustainable future. Green technology has not only transformed the energy sector but also improved lives, strengthened the economy, and reduced environmental impact.

While challenges such as energy storage and grid integration remain, the progress achieved so far is significant. India's renewable revolution demonstrates that a cleaner, greener future is not a distant goal but an ongoing reality—driven by innovation, policy, and the collective effort towards sustainable development. □



Rural India Needs Plastic-Free Supply Chains for a Green Growth

Plastic pollution has emerged as a major environmental and developmental challenge in India, particularly in rural areas where consumption patterns are rapidly changing but waste management systems remain limited. With rising incomes and expanding access to packaged goods, rural supply chains are increasingly dependent on plastic-based materials, leading to unmanaged waste accumulation and ecological stress. At the same time, India's vision of Green Growth and Viksit Bharat requires aligning economic development with environmental sustainability. This article examines the challenges of plastic dependence in rural supply chains and explores sustainable, circular, and bio-based alternatives that can enable a transition towards plastic-free rural economies.

Dr Harender Raj Gautam

Plastic pollution is a global challenge owing to its environmental persistence and negative impact on ecosystems, infrastructure, society, and the economy. The problem is also continuously growing in India as we generate one-fifth of global plastic waste. The proliferation of fast-moving consumer goods, driven by rising rural incomes and

aggressive marketing, has introduced high volumes of plastic into the supply chain in rural India, where waste management infrastructure is often missing.

The Household Consumption Expenditure Survey gives an indication of increasing household consumption and expenditure patterns, as the Monthly Per Capita Consumption Expenditure in 2023–24 is observed to be Rs. 4,122 in rural India, with a 9.2% increase from the

previous year. In rural India, food accounted for about 47% of the value of the average rural Indian households' consumption, and the contribution of beverages, refreshments, and processed food has been the highest (9.84%), which introduces plastic as packaging material.

Current Status of Plastic Usage

Plastic remains critical to supply chains by ensuring product safety, extending shelf life for food, and providing lightweight, cost-effective transport. However, plastic use in the supply chain poses a significant and growing threat to environmental sustainability and public health, as 98% of plastics are derived from fossil fuels, and thus emissions and environmental damage are expected to rise. Global plastic production reached 436 million metric tons in 2023. According to the United Nations, out of the plastic produced worldwide yearly, 33% is used just once.

The key end-use sectors of plastics are packaging (43%), infrastructure (21%), automotive (16%), agriculture (2%), and others (18%). The packaging sector is a key generator and consumer of plastic goods, which then become plastic waste. India, with an annual production of over 14.17 million metric tonnes, is the world's second-largest manufacturer of plastic polymers.

Further, the country produces 9.46 million metric tonnes (Mt) of plastic waste every year, which is equivalent to nearly one-fifth of global plastic waste. Unfortunately, recycling initiatives only manage to handle 25% of plastic waste, and the rest of the significant amount ends up in uncontrolled landfills. The uncollected plastic waste undergoes physical and chemical processes, such as weathering and ultraviolet (UV) radiation, and breaks down into small plastic particles like microplastics and nano-plastics, which are serious environmental concerns.

According to one estimate, 2.7 Mt of microplastics seeped into the environment in 2020, which is expected to double by 2040.

Challenges in Eliminating Plastic From Supply Chains

As per the Central Pollution Control Board's 2023 report, India generated roughly 9.46 million tonnes of plastic waste annually, of which about 43% comprised single-use plastic items. Despite growing recycling efforts, only 43% of urban households currently practise source-level waste segregation, and the infrastructure remains uneven across districts. Rural consumer goods markets in India are experiencing a significant resurgence, often outpacing urban growth due to a significant rise in per capita expenditure in villages. Packaged goods are now common, but packaging waste management is poor and it is rarely reported.

Existing research suggests a continuous flow of low-value plastic in villages, which is either burned or dumped unscientifically. The widespread use of multi-layered plastic packaging for products like shampoos, biscuits, and chewing tobacco products adds to the growing plastic waste burden in rural areas. According to the Central Pollution Control Board report of 2020–21, India produces over 160,000 tons per day of MSW, where plastic waste is often mixed with organic, biomedical, or hazardous components, making it economically and technically difficult to recycle.

The potential to transform waste into value hinges on how effectively plastics are segregated at source. Source segregation, which is the practice of separating waste at the point of generation, is mandated under the Solid Waste Management Rules, 2016, yet compliance remains low. "Waste Wise Cities" – a 2023 report by NITI Aayog indicates that only 17% of Indian households practise full waste segregation.

Traditional Alternatives and Local Systems

Several innovative, sustainable alternatives are effectively replacing conventional plastics in supply chains. By leveraging natural materials and traditional knowledge, these solutions provide biodegradable, reusable, or compostable options that reduce dependency on petroleum-based single-use plastics. Natural resources like bamboo, crop residues from paddy and wheat, paper/cardboard, bagasse (sugarcane fibre), mycelium (mushroom roots), seaweed-based films, and many other plant-based products offer great potential.





Bamboo: It is a highly promising, sustainable alternative to plastic in rural supply chains, a locally available material that can replace plastics in packaging in many sectors. It is renewable and biodegradable, maturing in three to four years and decomposing within six months. Unlike plastics, bamboo sequesters carbon and locks it in for the product's lifespan. India is the second richest country in the world after China in terms of bamboo genetic resources. The total bamboo-bearing area of the country is estimated to be 13.96 million ha. As per the Forest Survey of India, the total green weight of bamboo culms is estimated at 169 million tonnes. Bamboo can replace many single-use plastics, including straws, cutlery, cups, bowls, and food packaging.

Leaf-Based Packaging: Leaf-based packaging, a long-standing practice in many regions, represents a low-technology and culturally embedded option that is gaining attention. It is re-emerging as a bio-renewable and sustainable system of food packaging. The findings show that leaf-based packaging is most suitable for short shelf-life and low-risk foods, especially within traditional food service settings. Banana and palm leaves offer great potential due to their abundance, biodegradability, and mechanical strength. They are particularly effective for perishable items and food-related items in local markets.

Jute and Cotton Bags: Jute and cotton bags are emerging as primary, sustainable alternatives to plastic packaging in consumer goods supply chains, driven by their natural, biodegradable, and renewable properties. Jute bags are durable, biodegradable alternatives for transporting bulk goods and are commonly used for agricultural produce and in agricultural supply chains. While jute fabrics exhibit mechanical strength and eco-friendliness, their water-absorbing nature has proven to

be detrimental for all-weather and long-term storage. Jute bags can be further improved with innovative technologies, such as coating with paraffin wax to enhance water repellence.

Clay/Earthen Pots: The use of clay or earthen pots for packaging and storage in rural areas is a sustainable, cost-effective, and scientifically sound practice, particularly for food preservation, cooling, and water storage. As traditional alternatives, earthen pots offer numerous advantages, including natural cooling through evaporation, enhanced food safety due to alkaline properties, and complete biodegradability, serving as an eco-friendly alternative to plastic, especially in developing regions. Clay pots are ideal for setting yoghurt, making curd, or storing buttermilk. They are also used to store staples like dried tamarind, spices, and pulses, protecting them from moisture.

Crop Residues: Utilizing agricultural residues like wheat and paddy straw (rice stubble) in the supply chain to replace plastic is a rapidly emerging sustainable solution that converts a major pollutant into eco-friendly packaging materials. Startups and researchers are transforming this waste into biodegradable, compostable, and renewable alternatives to petroleum-based plastics. Pulping enables biomass pulp to be processed locally and further marketed to enterprises, which subsequently mould the pulp into several products, including packaging and paperboards that replace single-use plastics in numerous applications.

TIPA Compostable Packaging of Israel is using paddy straw to make trays that can be used for a variety of purposes, such as packaging fruits, vegetables, dry food, and even holding hot meals for up to 48 hours.



The company acquired Bio4Pack, a European leader in compostable packaging solutions. The Indian Institute of Technology Roorkee continues to pioneer sustainable innovations to tackle some of the world's most pressing environmental challenges. This institute, in collaboration with Parason Machinery India Pvt. Ltd., Aurangabad, has successfully developed eco-friendly tableware made from wheat straw. By converting wheat straw into moulded, biodegradable, and compostable tableware, the team has created a durable, heat-resistant, and food-safe alternative to conventional plastic. CRASTE is another example of an Indian startup converting rice and barley straw into packaging boxes, used by firms like IKEA and Nestlé.

Policy Support and Community-led Initiatives

Policy support is crucial in driving the transition away from single-use plastics (SUP) in India through mandatory Extended Producer Responsibility (EPR) guidelines and strict bans aimed at promoting sustainable, compostable alternatives. Phasing out plastic from supply chains requires an aggressive, multi-pronged approach that combines immediate reduction strategies with the simultaneous introduction of sustainable, circular alternatives. Key initiatives include strengthening the supply chain for alternatives, setting standards, and encouraging a circular economy.

The Ministry of Environment, Forest and Climate Change has already prohibited identified single-use plastic items with low utility and high littering potential, with effect from 1 July 2022. States and Union Territories have been asked to undertake regular enforcement drives to implement the ban on identified single-use plastic items. The Plastic Waste Management Rules, 2016 (as amended from time to time), mandate the use of 30% recycled content in rigid plastic packaging effective from 2025–26, with a gradual increase of 10% every year until reaching 60% in 2028–29 and onwards.

In a significant move to strengthen plastic waste management and promote a circular economy, the Ministry of Environment, Forest and Climate Change has issued finalised guidelines mandating the use of 40% recycled content in food-grade PET packaging for the fiscal year 2026–27. The directive follows a draft notification issued on 3 June 2025, which had allowed brands and producers to carry forward any shortfall in meeting the 30% recycled PET (r-PET) target for 2025–26 over a period of three years. This provision ensures a

phased but consistent transition toward higher recycled content in packaging materials.

There is a need for phasing out plastics in export supply chains for compliance with strict European Union (EU) regulations, including the Single-Use Plastics Directive. The new European Packaging Regulation, known as PPWR (Packaging and Packaging Waste Regulation), aims to reduce the growing volume of packaging waste in the EU and prevent its increase by 2030 through a functioning circular economy. As of 11 February 2025, it replaces the current Packaging Directive, introducing stricter regulations and ensuring uniform implementation across member states. In 2023, the European Union banned the sale of loose plastic glitter. Germany, Slovenia, and the Netherlands are already recycling over 50% of their plastic packaging waste, based on Eurostat 2024 data.

The Bureau of Indian Standards (BIS) has published IS 18267: 2023, “Food Serving Utensils Made from Agri By-Products – Specification,” aimed at reducing plastic pollution and promoting sustainability. The standard provides comprehensive guidelines to manufacturers and consumers, ensuring uniformity in quality requirements across the country. These specifications cover various aspects, including raw materials, manufacturing techniques, and performance and hygiene requirements for the production of biodegradable utensils. It specifies the use of agricultural by-products, such as leaves and sheaths, as preferred materials for making plates, cups, bowls, and more. The standard recommends appropriate parts of plants and trees and provides manufacturing techniques like hot pressing, cold pressing, moulding, and stitching.

The Food Safety and Standards Authority of India (FSSAI) has also embarked on a groundbreaking initiative to combat the rising issue of microplastic contamination in the Indian food supply. The FSSAI focus is to develop and standardize methods for detecting micro and nano-plastics in food products, while also assessing their prevalence and potential risks to consumers.

Role of Panchayati Raj Institutions: Panchayati Raj Institutions have a greater responsibility to check plastic pollution in the rural landscape as it has deleterious effects on animal and soil health. Plastic Waste Management Rules, 2016 (as amended in 2018) are applicable to rural local bodies. These Rules mandate specific responsibilities for Gram Panchayats

and coordination regarding plastic waste management in rural areas under their control. Till March 2025, 1168 blocks had functional Plastic Waste Management Units.

Sustainable Alternatives in Supply Chain

Sustainable alternatives to plastic in supply chains include biodegradable, bio-based materials like seaweed and fungi, alongside paperboard, cardboard, and recycled plastics (rPET). They work well with a variety of packaging materials, including boxes and bags. Glass is often positioned as a superior sustainable alternative to plastic in supply chains due to its ability to be infinitely recycled without loss of quality and its inert, non-toxic nature. Steel and aluminium are recyclable metals that are used in packaging because they are strong and can keep products fresh.

Natural Fiber-based Packaging Solutions: Natural fibres are renewable materials derived mostly from plants, seaweed, animals, and fungi. Cellulose is the most abundant natural and renewable polymer in the world, so it is a suitable option for replacing fossil-based materials. Cellulose can be extracted from many sources. It can be found in plant parts, marine animals (tunicates), algae, fungi, bacteria, invertebrates, and even amoebae.

Starch-based polymers are also becoming increasingly popular as eco-friendly substitutes for conventional plastics. These materials come from plant-based, renewable sources of starch like cassava, corn, and potatoes. Seaweed-based films hold significant potential as a sustainable, biodegradable alternative to fossil-fuel-based plastics in the supply chain, particularly for food packaging.

Fungal mycelium has the ability to grow rapidly on low-cost agricultural waste substrates, forming dense, fibrous structures that can be moulded into various shapes and hardened to create strong, lightweight materials. Several industries, including furniture, electronics, and cosmetics, have already adopted mycelium-based packaging for its biodegradability, low carbon footprint, and potential for circular production.

Biodegradable Plastic: Biodegradable plastic can play an important role as a substitute for conventional plastics, particularly for single-use applications. Polylactic acid (PLA) is one of the most widely used bio-based and biodegradable plastics, applied widely as a packaging material to produce disposable cups, bowls,

and bottles. Starch-based plastics are produced from thermoplastic starch that is blended with enhanced physical and mechanical properties, such as stiffness and strength.

A start-up based in Delhi, Dharaksha Eco-solutions, has addressed the issue of packaging by transforming agricultural waste, which is often burnt and contributes to plastic pollution, into eco-friendly packaging solutions. The Defence Research and Development Organisation (DRDO), in collaboration with a company based in Hyderabad, has developed biodegradable cutlery technology, which has helped to replace plastic spoons, plates, and teacups. Ishitva Robotic Systems aims to improve the recycling process through automation.

Future Lies in Circular Supply Chain

Circular economy strategies encompass activities commonly grouped as refuse, rethink, reduce, reuse, repair, refurbish, remanufacture, repurpose, recycle, and recover. To replace plastic, the inherent properties of food products, including perishability, specialized handling requirements, and stringent storage conditions, present unique challenges within supply chain management.

Circular economy behaviours in households could include purchasing alternative products that are reusable, recyclable, or made from recycled content, and purchasing products with no packaging or packaging that can be recycled or composted. A World Bank (2022) report found that India's recycling industry could grow to USD 6–8 billion by 2030 with the right segregation infrastructure and policy support.

Startups in plastic circularity, from waste-to-fuel to plastic bricks, are gaining traction, but they need reliable input material. Segregated waste provides that stability. Moreover, reducing dependency on virgin plastic through recycling could save more than 5 million tonnes of CO₂ annually, a significant contribution to India's climate commitments under the Paris Agreement.

By 2050, India's circular economy is expected to reach a market value of \$2 trillion and create 10 million jobs. To cut plastic pollution by 80% globally by 2040, the United Nations suggests first eliminating problematic and unnecessary plastics to reduce the size of the problem. Subsequently, it calls for implementing three market shifts - reuse, recycle, reorient, and diversify. □



Smart Solutions for Cleaner Villages

Driving Green Growth through Rural Sanitation and Waste Management

India's rural sanitation has undergone a major transformation under the Swachh Bharat Mission-Gramin (SBM-G), achieving near-universal toilet access and widespread ODF status. SBM-G Phase II (2020–26) shifts focus to sustainability through the ODF Plus framework, emphasising waste management and behavioural change. This article examines the transition from infrastructure-led sanitation to systems-based models, highlighting decentralised innovations and institutional roles. Despite progress, challenges in operation and maintenance, safe sludge disposal, and sustaining behaviour persist. It argues for community-owned circular sanitation systems to deliver environmental, health, and economic benefits, positioning rural India as a driver of sustainable development.

Dr Sudheer Kumar Shukla
Dr Harveen Kaur

Rural India is witnessing a quiet yet profound transformation. Open fields that once symbolised sanitation deprivation are steadily being replaced by toilets, compost pits, biogas units, and decentralised wastewater systems. This transformation is not merely infrastructural; it reflects a deeper behavioural and systemic shift.

In 2014, only about 39 per cent of rural households had access to toilets, and open defecation posed significant risks to public health, environmental quality, and women's safety (Ministry of Jal Shakti, 2021). The launch of the Swachh Bharat Mission-Gramin (SBM-G) triggered an unprecedented national movement, combining financial incentives, mass awareness campaigns, and community participation.

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By October 2019, over 10.6 crore toilets had been constructed, and more than 600,000 villages were declared ODF (Government of India, 2019). As of 2026, over 95 per cent of villages are progressing towards ODF Plus status, reflecting a shift from access to sustainability (Ministry of Jal Shakti, 2024). This transition marks a paradigm shift—from sanitation as infrastructure to sanitation as a circular, community-driven system.

Expanding the Sanitation Agenda

The success of SBM-G Phase I revealed new challenges. While toilets were constructed at scale, issues such as faecal sludge accumulation, greywater stagnation, and improper solid waste disposal began to emerge. Recognising this, SBM-G Phase II was launched with a broader focus on sustainability.

According to official data, by early 2026, approximately 5.68 lakh villages had achieved ODF Plus status, with significant progress in both solid and liquid waste management infrastructure (Ministry of Jal Shakti, 2024). This evolution reflects a shift towards integrated sanitation systems that address the entire waste cycle.

1. Decentralised Innovations

One of the defining features of India's rural sanitation success is the adoption of decentralised and context-specific technologies.

- a. **Biogas-Linked Toilets** : In Maharashtra, toilet-linked biogas systems convert human and animal waste into cooking fuel and organic manure. Studies indicate that a standard 2 cubic metre biogas plant can meet

the cooking needs of a household while reducing dependence on LPG and firewood (MNRE, 2022).

- b. **GOBARdhan Initiative** : Launched in 2018, the GOBARdhan scheme promotes the conversion of cattle dung and organic waste into biogas and compressed biogas (CBG). As of 2024, over 2,700 biogas plants have been registered, contributing to renewable energy generation and rural livelihoods (Department of Drinking Water and Sanitation, 2024).
- c. **Eco-Sanitation in Water-Scarce Regions** : In Ladakh and parts of the Northeast, urine-diverting dry toilets (UDDTs) offer water-efficient solutions. These systems enable nutrient recovery while conserving scarce water resources, demonstrating the relevance of traditional ecological knowledge (Agarwal et al., 2020).
- d. **Zero-Waste Models** : Cities such as Ambikapur and villages such as Punsari illustrate how decentralised waste segregation and composting can create zero-waste ecosystems, generating employment and revenue for local communities (CSE, 2021).

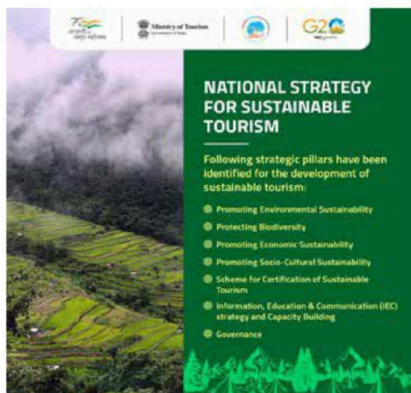
2. Building a Circular Rural Economy

Rural India generates approximately 0.2–0.3 kg of solid waste per capita per day, of which 60–70 per cent is biodegradable (CPCB, 2021). SBM-G Phase II leverages this resource potential through circular economy approaches.

Key interventions include:

- **Composting**: Vermicomposting and NADEP techniques convert organic waste into nutrient-rich fertiliser.
- **Biogas production**: Household and community digesters generate renewable energy and slurry manure.
- **Plastic waste utilisation**: Segregated plastic waste is used in road construction and recycling.
- **Greywater reuse**: Constructed wetlands and soak pits enable reuse for irrigation.
- **Faecal sludge treatment**: FSTPs ensure the safe treatment and reuse of sludge.

These systems generate economic value while reducing environmental pollution. Estimates suggest that households can save between ₹500 and ₹1,500 per month through reduced fuel and fertiliser costs (World Bank, 2022).



CIRCULAR ECONOMY IN RURAL INDIA

A circular economy approach focuses on resource efficiency, waste minimisation and value recovery from biological and agricultural waste.



3. Technology and Digital Monitoring

Digital tools are increasingly strengthening rural sanitation systems. The SBM-G Management Information System (MIS) enables real-time monitoring of sanitation infrastructure, including geo-tagging of toilets and waste management assets.

Mobile applications support desludging services, waste collection tracking, and grievance redressal. In pilot areas, IoT-based sensors are being used to monitor system performance and detect leakages. These innovations enhance transparency, accountability, and service delivery efficiency.

Convergence with Flagship Programmes

The success of rural sanitation is closely linked to convergence with other government initiatives:

- **Jal Jeevan Mission (JJM):** Ensures water supply, which is essential for sustaining sanitation systems.
- **MGNREGA:** Supports the construction of soak pits, drainage systems, and compost units.
- **National Rural Livelihoods Mission (NRLM):**

Mobilises women's groups for waste management enterprises.

- **Finance Commission Grants:** Provide funding for ODF sustainability.

Such convergence reduces costs, enhances efficiency, and strengthens institutional capacity (NITI Aayog, 2023)

Challenges and Gaps

Despite significant progress, several challenges persist:

- **Behavioural sustainability:** Studies indicate that 5–10 per cent of households may revert to open defecation in the absence of sustained awareness (UNICEF, 2021).
- **Operation and maintenance:** Limited financial and technical capacity at the Panchayat level affects system sustainability.
- **Faecal sludge management:** Inadequate desludging services and treatment infrastructure remain a concern.

- **Plastic waste:** Increasing non-biodegradable waste poses new environmental challenges.
- **Regional disparities:** Diverse climatic conditions require tailored technological solutions.

Financing Sustainable Sanitation

Rural sanitation financing has evolved from subsidy-driven models to more diversified approaches.

Key sources include:

- Government incentives under SBM-G
- Public–Private Partnerships (PPPs) for service delivery
- Microfinance and SHG-based enterprises
- Revenue from compost, biogas, and recyclables
- Emerging carbon financing opportunities

Such models promote financial sustainability and reduce dependence on public funds (World Bank, 2022).

Impact on Health, Environment, and Livelihoods

Improved rural sanitation has generated multidimensional benefits:

- **Health:** Reduction in diarrhoeal diseases and child mortality; WHO estimates link improved sanitation to significant health gains (WHO, 2020).
- **Environment:** Reduced groundwater contamination, improved soil health, and lower greenhouse gas emissions.
- **Economy:** Employment generation and reduced healthcare expenditure.
- **Gender empowerment:** Enhanced dignity, safety, and participation of women.

These outcomes align with the Sustainable Development Goals, particularly SDG 6 (Clean Water and Sanitation) and SDG 13 (Climate Action).

Villages as Engines of Sustainability

India's rural sanitation journey demonstrates the power of collective action, policy innovation, and community participation. The transition from open defecation to ODF Plus reflects a deeper shift towards sustainability and resilience.

Rural villages are no longer passive beneficiaries of development; they are emerging as active drivers of the circular economy and green growth. By transforming

waste into resources, they offer scalable models for sustainable development.

As India moves towards the vision of *Viksit Bharat 2047*, rural sanitation will play a pivotal role in shaping a cleaner, healthier, and more sustainable future.

Way Forward

Achieving universal ODF Plus status requires a phased and integrated approach that balances infrastructure, institutions, and sustainability.

- **Short term:** The priority is to ensure universal coverage and functionality of Solid and Liquid Waste Management (SLWM) systems, along with strengthening district-level faecal sludge management (FSM) infrastructure to safely handle waste streams.
- **Medium term:** The focus should shift towards developing cluster-based waste processing systems for greater efficiency and expanding the role of Self-Help Groups (SHGs) in sanitation services, thereby creating local livelihoods and strengthening community ownership.
- **Long term:** Rural sanitation must evolve into a circular and climate-resilient system by integrating bioenergy solutions such as biogas, leveraging carbon credit opportunities, and institutionalising digital monitoring for transparency and efficiency.

Together, these steps can transform rural sanitation into a key driver of green growth and sustainable development.

Conclusion

India's transition to the ODF Plus framework signifies a major shift from infrastructure-led sanitation to sustainable, circular, and community-driven systems that integrate solid and liquid waste management, faecal sludge treatment, and plastic waste control, delivering environmental, health, and economic benefits.

However, to ensure long-term success, it is essential to strengthen behavioural change initiatives, institutionalise robust operation and maintenance mechanisms at the Panchayat level, scale decentralised and context-specific waste management solutions, enhance capacity and financing through public–private partnerships and self-help groups, and leverage digital monitoring and innovative financing mechanisms such as carbon credits. □



India's Comprehensive Empowerment Model for Workers Towards a Unified and Inclusive Workforce

India's labour landscape is undergoing a historic transformation through the introduction of four Labour Codes and targeted initiatives such as the Pradhan Mantri Viksit Bharat Rozgar Yojana (PMVBRY). These reforms aim to simplify compliance, expand social security and bring informal and gig workers into the formal economic framework. By balancing worker welfare with enterprise efficiency, India is moving towards a more transparent, inclusive and future-ready labour ecosystem. However, successful implementation will depend on strong administrative capacity, regulatory clarity and active stakeholder collaboration to address emerging challenges and ensure sustainable, equitable growth.

Manjula Wadhwa

In cities and villages across India, millions of people wake up each morning to uncertain employment. Street vendors arrange their wares, construction workers gather at labour chowks, domestic workers begin their daily rounds, and countless others earn their livelihoods without formal employment contracts or job security.

India's unorganised and informal workforce, nearly 45 crore people forms the living infrastructure on which the nation stands.

These workers build cities, sustain supply chains, support households, drive transport systems, power the gig economy and underpin both agricultural and urban labour markets. Yet, despite being the backbone of India's economy, they remain among the most

invisible and vulnerable participants in the country's development story. Their lives are marked by low wages, unstable employment, lack of social security, poor living conditions and weak legal protection.

This stark disconnect between the scale of India's economic ambitions and the precarious reality of its labour force raises a fundamental question: Can a nation aspiring to global leadership truly achieve its goals without ensuring dignity, justice and protection for those who sustain its growth?

From Welfare to Empowerment: A Paradigm Shift

India possesses a wide spectrum of labour laws and protections; however, the rights often exist only on paper and workers frequently remain unaware of them. Welfare boards are in place, yet registration levels remain low. Digital portals have been created, but many workers lack digital literacy or access to identity-linked systems. This implementation deficit is one of the most significant challenges confronting India's labour governance.

To address these structural issues, it is imperative that India shifts from a purely welfare-oriented approach to a comprehensive empowerment model. The country's development cannot be assessed solely through indicators such as GDP growth, infrastructure expansion or digital innovation. It must also be measured by how secure workers feel, how fair their wages are and how accessible social protections are.

Labour Law Reforms: A Unified Framework

In pursuit of this objective, the Government of India has implemented comprehensive labour law reforms, effective from 21 November 2025, aimed at modernising the country's employment framework. The four new labour codes consolidate 29 existing labour laws into a simplified and unified system. These reforms apply to all categories of workers including full-time, part-time, contractual and gig workers. They are designed to improve transparency, enhance employee benefits and ensure timely payment of wages and access to social security.

Four New Labour Codes

- Code on Wages, 2019
- Industrial Relations Code, 2020
- Code on Social Security, 2020
- Occupational Safety, Health and Working Conditions Code, 2020 .

These reforms aim to simplify compliance, ensure minimum national standards and recognise evolving work arrangements including gig and platform-based employment.

Key Transformational Changes

Let us now examine the twelve most significant changes in labour laws that every employee and employer should be aware of. Under the new Code on Wages, all employees, irrespective of sector or wage



level are entitled to a statutory minimum wage. A national floor wage has been established by the Central Government to ensure fair remuneration across both organised and unorganised sectors.

The revised definition of wages mandates that basic pay must constitute at least 50 per cent of the total salary. While this may reduce immediate take-home pay, it increases contributions to the Provident Fund and gratuity, thereby enhancing long-term retirement benefits.

For the first time in India, gig workers, freelancers, and platform-based professionals have been brought within the ambit of social security schemes. Digital platform companies are required to contribute a portion of their annual turnover to a dedicated fund covering life insurance, health, and disability benefits.

The minimum service requirement for gratuity has been reduced from five years to one year for fixed-term employees, enabling quicker access to benefits. Employers are now required to issue formal appointment letters to all workers, including those in informal and unorganised sectors, thereby improving job documentation, wage transparency and access to social security.

Employees working beyond scheduled hours are entitled to overtime wages at twice the standard rate, strengthening labour rights and discouraging unpaid overwork. The eligibility period for leave has been reduced from 240 days to 180 days, making it easier for workers to avail themselves of leave benefits.

Women employees are now permitted to work before 6 a.m. and after 7 p.m. across sectors, subject to their consent and the provision of adequate safety measures by employers. Flexible working arrangements, including work from home have also received formal recognition.

To promote preventive healthcare and workplace well-being, employers are required to provide free annual health check-ups for employees above 40

years of age. Additionally, wages must be disbursed within seven days of the end of the wage period, or within two working days in cases of resignation or termination, thereby ensuring timely payments and financial security. Compensation for commuting accidents has also been introduced, expanding the scope of worker protection.

Impact of Rationalisation: From 29 Laws to 4 Codes

Parameter	Earlier	Now
Rules	1436	351
Returns	31	Single (Electronic)
Forms	181	73
Registers	84	08
Registration	8*	Single
Licence	4	Single
Compounding	—	Introduced
Improvement Notice	—	Introduced

Includes Factories, BOCW, Contract Labour, Plantation, Motor Transport, ISMW, ESI, and EPF
Source: Ministry of Labour & Employment

Bridging the Gap: Inclusion of Gig Workers

The Code on Social Security, 2020 marks a significant step towards recognising gig and platform workers. However, gaps remain when compared to traditional employees. While the framework exists, its effectiveness will depend on robust implementation, regulatory clarity, and sustained monitoring.

PM Viksit Bharat Rozgar Yojana: Driving Employment

Another significant initiative by the Government of India is the introduction of the Pradhan Mantri Viksit Bharat Rozgar Yojana, 2025. The scheme aims to generate employment, enhance employability and promote formalisation of the workforce.

The scheme comprises two components: Part A incentivises youth entering the workforce for the first time, while Part B provides incentives to employers for generating and sustaining employment. With an outlay of ₹1 lakh crore, the scheme aims to support the creation of over 3.5 crore jobs within two years.

Under the scheme, newly employed youth are eligible for incentives of up to ₹15,000 in two instalments. Employers, on the

Labour Right/Benefit	Traditional Employees	Gig/Platform Workers
Minimum Wages	Mandated	Not mandated
Paid Leave	Mandated	Not mandated
Gratuity	Entitled	Not mandated
Health Coverage	Structured schemes	Welfare-based schemes
Documentation	Appointment letters	Registration-based

other hand, can receive up to ₹3,000 per month per new employee for generating additional employment opportunities. In the manufacturing sector, these incentives are extended to the third and fourth years as well.

To encourage a culture of savings, a portion of the incentive will be deposited in a fixed savings instrument, which can be withdrawn by the employee at a later stage. The benefits of the scheme will be applicable to jobs created between 1 August 2025 and 31 July 2027.

While analysing the impact of the new labour laws, it is evident that by consolidating 29 existing laws into four cohesive codes, India has moved closer to creating a labour ecosystem that balances economic growth with worker's welfare. These reforms strengthen the foundation of a future-ready, digitally enabled, and inclusive workforce. The full rollout of these Labour Codes on 21 November 2025 (with complete implementation envisaged by April 2026) marks the end of decades of regulatory fragmentation. By simplifying compliance, recognising modern work arrangements, and ensuring minimum national standards, these reforms aim to create a transparent, worker-friendly, and investment-attractive labour ecosystem.

Similarly, the Pradhan Mantri Viksit Bharat Rozgar Yojana (PMVBRY) is a forward-looking and impactful initiative that balances employee welfare with employer incentives. By combining skill development, financial literacy and direct benefits with targeted incentives for employers, the scheme is expected to stimulate job creation, formalisation and productivity in the Indian labour market. As India progresses towards the vision of *Viksit Bharat @ 2047*, PMVBRY can serve as a cornerstone in shaping a more inclusive and dynamic employment landscape.

From the perspective of employees, the scheme promotes the formalisation of jobs through expanded social security coverage. It also enhances employability by providing on-the-job training, particularly for first-time entrants to the workforce, while fostering financial literacy. For employers, the scheme helps offset the costs associated with job creation, enhances workforce stability and productivity, and incentivises wider social security coverage. Furthermore, the scheme complements initiatives such as the National Manufacturing Mission by encouraging the entry of new industries and the expansion of existing ones, particularly in labour-intensive sectors.

Implementation Challenges and the Road Ahead

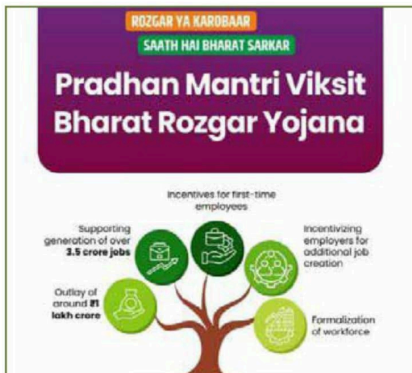
However, not all aspects of the transition are without challenges. While the revised labour laws offer significant opportunities such as a boost to employment generation in MSMEs and manufacturing, greater formalisation of the workforce, enhanced EPFO coverage, improved productivity and skill development, extended incentives for the manufacturing sector, and better compliance through data integration, there are also short-term implementation concerns.

One key challenge lies in aligning with the revised definition of wages. Ambiguities in interpretation, particularly concerning variable or one-time payments and stock-based benefits, may create compliance complexities. Employers may need to reassess cost structures and recalculate benefits such as gratuity and leave encashment, which in the absence of clear guidance, could have retrospective implications.

For instance, gratuity is calculated based on the last drawn salary for each completed year of service. Changes in the definition of wages may increase

Comparison of Labour Rights: Traditional Employees vs. Gig/Platform Workers

Labour Right/Benefit	Traditional Employee (Statutory Right)	Gig/Platform Worker (CoSS 2020 Provisions)
Statutory Minimum Wages	Mandated entitlement	Not mandated
Paid Leave	Mandated entitlement	Not mandated
Gratuity/Severance	Legal entitlement upon completion of service	Not mandated
Health Coverage	ESIC/employer-funded contributory insurance	Coverage through welfare schemes funded via non-wage levy
Formal Documentation	Mandatory appointment letters	Mandatory registration/Unique Identification (UAN)



gratuity liabilities for employees exiting after the implementation of the new codes. Additionally, gratuity obligations for fixed-term employees including existing ones must also be accounted for.

Organisations will need to undertake comprehensive classification of their workforce categorising employees, workers, and gig workers based on roles and remuneration to ensure compliance and operational clarity. Strengthening documentation and maintaining robust records will also be critical.

Moreover, organisations that rely heavily on contract labour must reassess their workforce strategies in light of evolving regulatory provisions, particularly those restricting outsourcing in core functions and introducing a unified registration framework. These changes may require a shift towards more strategic workforce planning across sectors such as IT, logistics, manufacturing, and engineering, where contract staffing plays a significant role.

Likewise, the Social Security Code, 2020 has created a framework to bring workers, who until recently had no formal recognition within the ambit of social security coverage. However, a degree of uncertainty remains regarding the extent to which these provisions can be effectively implemented without strong administrative follow-up and institutional capacity.

For effective implementation, the focus must now shift towards operational execution, regulatory harmonisation, and robust monitoring:

- **Expedient Finalisation of Schemes:** The prompt notification of Central schemes, along with clear

operational guidelines, is essential to address ambiguities in terms such as “payout” and “turnover”, as the effectiveness of benefits depends on these definitions.

- **Harmonisation of Regulatory Frameworks:** A coherent strategy is required to reconcile varying state-level approaches such as turnover-based versus transaction-based levies to ensure regulatory uniformity for national-level aggregators.
- **Preventing Cost-Shifting:** Strong enforcement mechanisms must be established to prevent aggregators from transferring the burden of contributions onto workers through reduced wages or incentives, thereby undermining the intent of the reforms.
- **Assessing Fund Adequacy:** Continuous actuarial assessment is necessary to evaluate the sustainability of the 1–2 per cent levy, particularly in view of the rapid expansion of the gig workforce and the long-term nature of benefits such as pensions.

Like many other policy initiatives, the Pradhan Mantri Viksit Bharat Rozgar Yojana (PMVBRY) also faces certain implementation challenges. Complexity in determining baseline and threshold levels; Risk of misuse and inflated employment data; Compliance burden for smaller establishments and Dependence on EPFO IT systems for timely disbursement of benefits.

Conclusion

The introduction of the new Labour Codes and the Pradhan Mantri Viksit Bharat Rozgar Yojana marks a transformative step in India’s labour landscape. These initiatives seek to balance worker welfare with enterprise efficiency, while simplifying compliance, promoting workplace safety and ensuring fairness in wages.

Collectively, these reforms lay the foundation for a more equitable, transparent and growth-oriented economy. They reaffirm India’s commitment to building a modern labour ecosystem that empowers both workers and industry, thereby enabling inclusive and sustainable development.

However, the success of these reforms will depend on effective stakeholder collaboration, strong enforcement mechanisms and continuous alignment with global best practices. Achieving these objectives will be critical to realising the full potential of these reforms and ensuring long-term, sustainable growth. □

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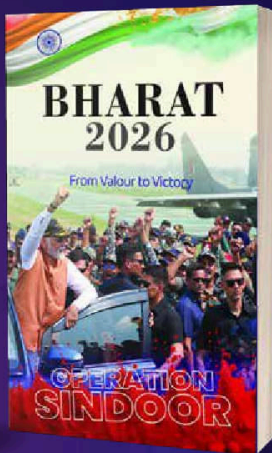
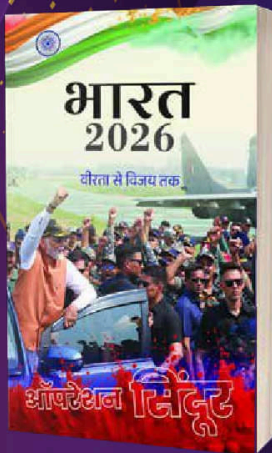
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