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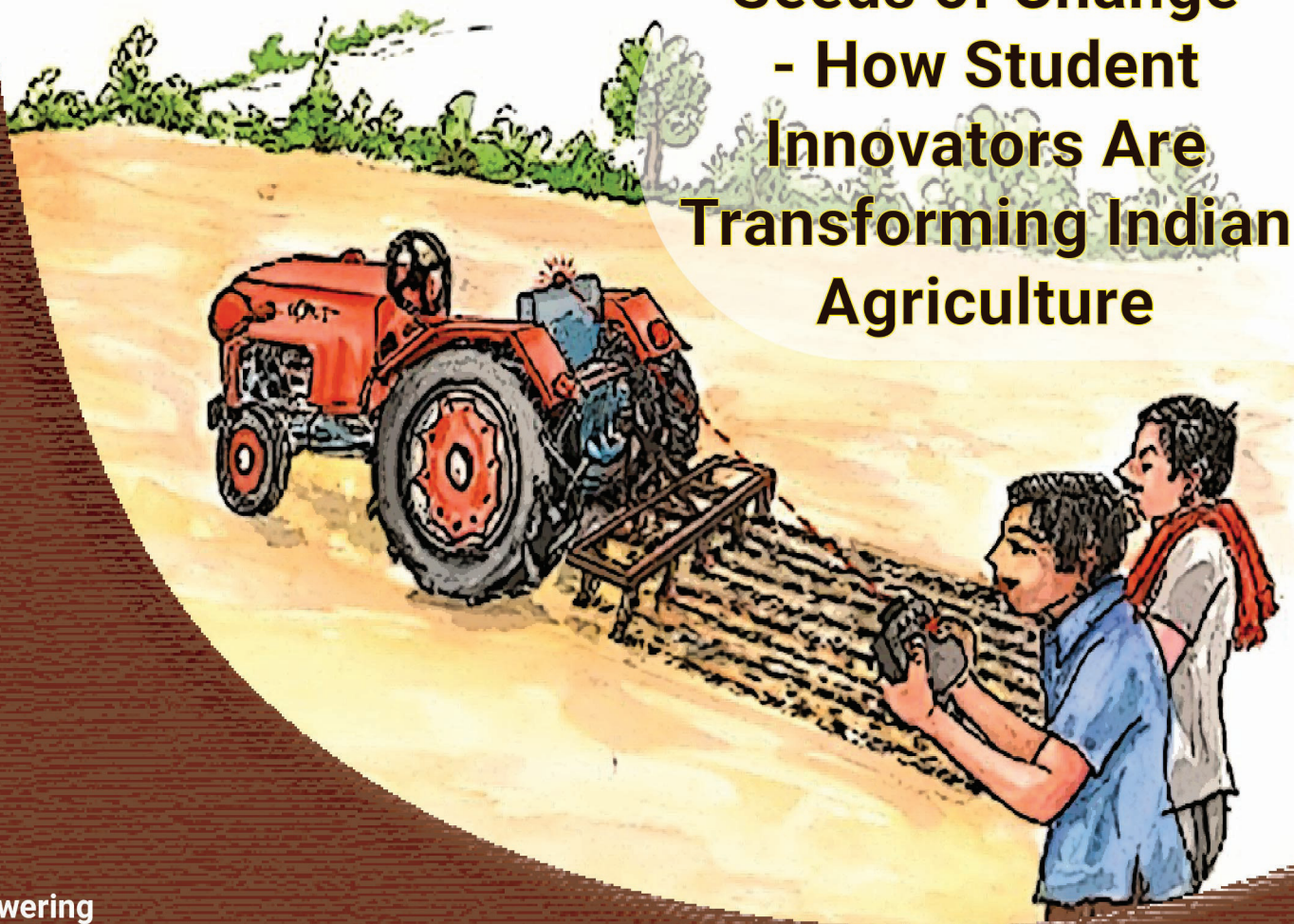
Autonomous Institute of the Department of Science and Technology, Govt. of India

# Innovation

## Frontline

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### Seeds of Change - How Student Innovators Are Transforming Indian Agriculture



Empowering  
Farmers through  
Knowledge

Exchange - On-Farm  
Interaction at Disang  
Chapori, Sivasagar,  
Assam

Building Grassroots  
Innovation Ecosystems  
in Southern Bastar  
Region, Chhattisgarh

Driving Sustainability  
through Grassroots  
Innovations - NIF and  
the 2030 Development  
Agenda

Women-Led  
Enterprise  
Development for  
Viksit Bharat @  
2047

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# Editorial

India's rise to 38th position in the Global Innovation Index (GII) 2025, from 81st in 2015, represents a sustained national progress in building innovation capacity. The country leads all lower-middle-income economies and dominates Central and Southern Asia, demonstrating its ability to outperform economic peers. For fifteen consecutive years, India has remained an "innovation overperformer," generating more innovation output than its development level would predict. Most striking is the asymmetry between inputs and outputs, as India ranks 52nd in innovation inputs but achieves 32nd in outputs, signaling how institutional mechanisms and entrepreneurial culture amplify investment into innovation.

India has demonstrated exceptional global performance in key competitive areas. The nation leads worldwide in IT and tech services exports, leveraging decades of investment in software engineering and IT infrastructure. In the innovation ecosystem, India ranks fourth in late-stage venture capital deals, eighth in intangible asset value, and ninth in startup funding access, with unicorn valuations reaching 4.02% of GDP. Patent filings surged to sixth globally, with the patent-to-GDP ratio more than doubling from 144 in 2013 to 381 in 2023. The country is also globally the third-largest domestic market with strong rankings in entrepreneurship policies (12th), investment rate (14th), and R&D spending by top corporations (16th), creating a robust foundation for sustained economic growth and technological advancement.

India's national policy architecture has catalysed this remarkable progress through strategically designed interventions. The foundational trinity of JAM (Jan Dhan-Aadhar-Mobile) and Digital India created critical infrastructure, enabling the Unified Payments Interface to process billions of monthly transactions and drive financial inclusion. Building on this digital architecture, Make in India, Startup India, and Production Linked Incentive (PLI) schemes have strengthened manufacturing competitiveness and fostered entrepreneurial culture, contributing to India's global reputation in innovation and entrepreneurship policies. The government has deepened its commitment to frontier technologies through the National Semiconductor Mission, IndiaAI Mission, PLI 2.0 schemes for IT hardware and automobile technologies, and most recently, the ₹1 lakh crore Research, Development, and Innovation (RDI) scheme for joint funding of R&D activities. Critically, innovation is being participatory and inclusive through the Atal Innovation Mission and NIF-led innovation initiatives and INSPIRE-MANAK programmes, which promote and recognise scientific experimentation in schools, villages, tribal hamlets, and grassroots communities across India. This comprehensive approach of integrating digital infrastructure, economic incentives, deep tech investments, and grassroots innovations creates a robust bedrock for sustained technological emergence and reshapes institutional culture toward entrepreneurial risk-taking.

However, India's innovation trajectory presents significant opportunities for strategic improvements. Our R&D spending at 0.65 percent of GDP offers substantial room for growth toward benchmarks set by global leaders. Moreover, Infrastructure (ranked 61st globally) and business sophistication (64th) represent other priority areas where targeted investments can produce major productivity gains, particularly in areas of knowledge-intensive employment and gender-inclusive participation.

On the path of transformation to Viksit Bharat by 2047, India aspires to construct an innovation architecture that is globally competitive as well as rooted in Indian social, cultural, and ecological ethos. By channelling policy focus toward infrastructure modernization and broadening participation across the geographies, the nation can translate its entrepreneurial potential into comprehensive global innovation leadership that honors its unique civilizational values while meeting universal standards of excellence. ■

**Dr. Arvind C. Ranade**

# Seeds of Change

## - How Student Innovators Are Transforming Indian Agriculture

Kanti Patel, Sunil Makvana

*“The farmers of tomorrow may still sow seeds in the soil, but today’s student innovators are sowing seeds of hope.”*

India has long been an agriculture-driven nation. The sector contributes nearly 18% to the country’s GDP and directly provides livelihood to around 46% of the workforce. When indirect employment in agri-input manufacturing, post-harvest processing, handicrafts, and the food industry is included, agriculture’s employment footprint expands by another 10–15%. Yet, despite this central role in the economy, a large segment of India’s farming community continues to struggle with poverty. Tractors, threshers, and even basic implements remain beyond the financial reach of many. In numerous villages, such equipment is either prohibitively expensive or simply unavailable, compelling farmers to depend on outdated, labour-intensive practices.

In recent years, however, Indian agriculture has witnessed a remarkable transformation, propelled by the creativity and determination of the nation’s youth. Farming is no longer perceived merely as a traditional livelihood—it is emerging as a vibrant arena for innovation, with students leading this change. Leveraging their academic knowledge and technological expertise, these young minds are tackling persistent challenges and spearheading the rise of agri-tech and agri-preneurship across the country.

From pioneering sustainable farming practices and smart irrigation systems to developing digital platforms that enhance

market access for small-scale farmers, youth-led innovations are redefining the agricultural landscape. These initiatives integrate technology, business insight, and social responsibility—fueling not only the growth of dynamic startups but also fostering a more resilient, efficient, and profitable farming ecosystem.

Encouraging this spirit of innovation, the National Innovation Foundation–India (NIF) continues to nurture creativity among children and youth, identifying and supporting ideas with the potential to transform agriculture and rural livelihoods. Through such efforts, India’s young innovators are shaping a brighter, more inclusive future for farming—championing sustainable, accessible, and impactful solutions. The following stories highlight how simple, affordable ideas can create transformative change in the lives of small and marginal farmers.

### Case Study 1 - Innovative Solar Thresher: Reducing Drudgery for Marginal Farmers

Dipankar Das, Andaman and Nicobar Islands

Granted Patent No: 498500

Dipankar Das, student from Diglipur, Andaman & Nicobar Islands, exemplifies grassroots innovation by developing a solar-powered thresher to alleviate the drudgery experienced by small and marginal farmers like his parents, who traditionally spent hours manually threshing pulses due to unaffordable machinery and unreliable electricity.



Solar Thresher

Motivated by empathy and his passion for science, he designed a compact, versatile, solar-driven thresher capable of efficiently processing crops such as green gram, black gram, pigeon pea, and horse gram. The machine’s user-friendly, low-cost design enables practical adoption in remote areas, reducing labor demands especially for women and cutting harvest processing time to minimize crop losses. Dipankar’s achievement not only highlights the social and economic potential of frugal innovation, but also demonstrates how youthful scientific creativity can deliver cost-effective solutions directly improving rural livelihoods.

### Case Study 2- Empowering Fields with Sunlight: Subash’s Solar-Powered Drill

Subash Chandra, Pudukkottai, Tamil Nadu

Granted Patent No: 448848

Subash, a young innovator from a farming family in Pudukkottai, Tamil Nadu, tackled labor shortages in agriculture by engineering a solar-powered seed drill that streamlines sowing operations while reducing reliance on fossil fuels. His “solar seeder” is equipped with a hopper and a customized wooden roller that



accurately dispenses seeds into soil at adjustable depth and spacing, ensuring optimal crop density and minimal waste. By integrating solar energy as its primary power source, the device functions effectively in off-grid rural areas and offers crucial relief from manual sowing, enabling smallholders to operate efficiently despite labor constraints.



*Solar Powered Drill*

Subash's solution stands out as a practical application of sustainable engineering, demonstrating how youth-led innovation can improve farm productivity and resilience in resource-limited contexts.

### **Case Study 3 - Leaf to Livelihood: Bharat's Mechanized Solution for Forest Communities**

**Bharat Bhima, Dantewada, Chhattisgarh**

**Granted Patent No: 498334**

In the forests of Dantewada, Chhattisgarh, where tribal livelihoods depend heavily on the collection of Tendu leaves for medicinal and commercial uses, Bharat Bhima has revolutionized a traditionally laborious process with his patented mechanized leaf-plucking device. Formerly, workers including women and the elderly had to spend hours bent over, manually plucking and sorting leaves, leading to fatigue and low returns.



*Tendu Leaves Plucker*

Bharat's innovation automates both plucking and size-based sorting, utilizing a harvesting mechanism that delicately collects leaves while preserving their commercial quality and sorting them for easier packaging and market sale. This dual-function technology drastically improves efficiency and ergonomic safety, enabling collectors to work more comfortably and productively while enhancing income and welfare for tribal communities in the region.

### **Case Study 4 - Women's Relief-Hands-Free Mahua Flower Collector**

**Lipsa Pradhan, Bargarh, Odisha**

**Granted Patent No: 449944**

In western Odisha's Mahua-rich regions, seasonal Mahua flower harvesting sustains many rural households but traditionally demands physically taxing, time-intensive labor from women who spend hours bent over gathering blossoms from the forest floor. Moved by her mother's hardship, Lipsa Pradhan of Bargarh designed an ergonomic, mower-like device with rolling brushes or paddles that sweep flowers into an attached container as the user walks upright, eliminating repetitive bending and exertion.



*Mahua Flower Collector*

This patented machine drastically improves harvest efficiency and reduces musculoskeletal strain, enabling women and elderly field workers to collect more blossoms in less time, thereby boosting household incomes and strengthening economic resilience

during the Mahua season. Lipsa's innovation stands out as a practical product of empathy and scientific thinking, making labor safer and more rewarding for vulnerable rural communities.

### **Case Study 5 - Digging Smart: The Energy-Saving Sweet Potato Digger**

**Sebati Kutruka, Bhubaneswar, Odisha**

**Granted Patent No: 519414**



*Sweet Potato Digger*

Harvesting root crops like sweet potatoes is traditionally a strenuous and time-intensive process for small and marginal farmers, often requiring hours of manual digging that causes musculoskeletal strain and heightened risk of injury. To address these issues, Sebati Kutruka from Bhubaneswar, Odisha, developed a patented spring-loaded lever digger specifically for sweet potatoes and similar crops. Her machine uses a mechanical lever with an engineered spring: when pressed, the blade penetrates the soil, and as the handle is lifted, stored spring energy helps gently pry up the crop—a design that streamlines extraction, minimizes manual effort, and reduces crop damage, making harvesting quicker and safer for rural growers.

### **Case Study 6 - Walk and Sow: Subhra's Seed Drill-Fitted Shoes**

**Subhra Suchismita Patel, Bhubaneswar, Odisha**

**Granted Patent No: 492474**

Subhra Suchismita Patel from Bhubaneswar, Odisha, offers a novel solution to the physically

taxing process of seed sowing among small and marginal farmers by integrating a miniaturized seed drill into a pair of wearable shoes. This innovation replaces repetitive bending and manual seed placement with a system where the shoe's front sole houses a digging attachment that creates a hole in the soil with each step, while embedded compartments dispense a seed automatically into each freshly made cavity. Further, brushes at the heel gently cover the seed as the wearer moves forward, enabling the sequential actions of digging, sowing, and covering to occur seamlessly with the natural stride.



Shoes with seed drill for farmers

The result is a streamlined, ergonomic method that increases planting efficiency, reduces physical effort, and delivers consistent seed spacing demonstrating practical application of engineering design to grassroots agricultural challenges.

### **Case Study 7 - Rooted Innovation: Empowering Tapioca Farmers with a Hand-Lever Digger**

**S Vanchinathan, Erode, Tamil Nadu**

**Granted Patent No: 431768**

S. Vanchinathan from Erode, Tamil Nadu, engineered a lever-based, hand-operated tapioca root digger to overcome the labor-intensity and ergonomic strain of traditional root crop extraction. By utilizing the principle of mechanical advantage through a fulcrum and specially

designed blade configuration, his tool efficiently loosens compact soil and uplifts deep-set, bulky tapioca tubers with minimal muscular effort.



Tapioca uprooter

The manual device is low-cost, robust, and easily operable, making advanced mechanization accessible to resource-poor farmers while accelerating harvesting and reducing long-term musculoskeletal stress. Vanchinathan's innovation both enhances farm productivity and aligns with eco-friendly practices, serving as a model of socially responsible problem-solving for rural economic resilience.

### **Case Study 8 - The Handle That Does It All: Sneha's Eight-in-One Farm Tool**

**Sneha Chakraborty, Khowai, Tripura**

**Granted Patent No: 498355**

Sneha Chakraborty from Khowai, Tripura, addressed the challenge of tool management for smallholder farmers by inventing a scientifically designed, multipurpose handle system featuring eight interchangeable attachment-including cutters, diggers, weeders, and harvesters-that fit within a single, ergonomically crafted hollow handle.



Multipurpose tool for agricultural use

This modular toolkit enables operators to seamlessly switch between various farm and household tasks, reducing clutter, minimizing tool misplacement, lowering storage needs, and consolidating multiple functions into one cost-effective purchase. The compact, user-friendly design especially benefits settings with limited space and resources, and its quick-change mechanism and ergonomic focus helps reduce repetitive strain while improving usability during prolonged use. Inspired by her grandfather's daily struggles, Sneha's innovation demonstrates how evidence-based, context-driven design can empower rural communities and foster scalable, transformative agricultural solutions.

### **Case Study 9 - Harvest Without Hurt: The Sea Buckthorn Picker**

**Tsering Omphel, Kargil, Ladakh**  
**Granted Patent No: 428116**



Sea Buckthorn Harvester

In the extreme climates of Ladakh and the greater Himalayan region, where sea buckthorn (*Hippophae rhamnoides*) berries are nutritionally prized but notoriously difficult and hazardous to harvest due to dense thorns and short stalks, Tsering Omphel of designed a lightweight, ergonomic, and cost-effective plucking device specifically for this context. The tool enables users to extract berries swiftly while keeping their hands safely away from sharp thorns, significantly reducing injury risk and minimizing the fruit loss typically caused by crude manual methods, which can result in up to



13% post-harvest waste. By facilitating safer and more thorough harvesting, the device empowers small-scale collectors to increase yields and income from this vital crop, which is rich in vitamins, carotenoids, and omega fatty acids. Supported by a patent and recognized by the National Innovation Foundation, Omphel's invention exemplifies how locally informed engineering can enhance occupational safety, nutritional security, and economic resilience in high-altitude rural communities.

### Case Study 10 - Smart Handle, Safe Harvest: Integrating First Aid Into Farm Tools

Kishan Hanuji Thakor,  
Gandhinagar, Gujarat

Patent Application No:  
201921048387

To enhance farm safety and address the high incidence of accidental cuts and abrasions during harvesting and weeding, Kishan Hanuji Thakor from Gandhinagar, Gujarat, innovatively designed a sickle with a built-in first-aid kit integrated directly into the handle.



*Sickle with first aid kit*

This patent-protected tool provides a concealed compartment containing essential medical items such as bandages, antiseptic wipes, and plasters, allowing immediate, on-the-spot wound care in remote or under-resourced agricultural settings where delayed treatment can increase infection risk and work downtime. The ergonomic design ensures the compartment

remains securely closed during use but is easily accessible in an emergency, merging practical utility with occupational health protection. By embedding safety infrastructure into a daily agricultural implement, Kishan's invention exemplifies how thoughtful design can advance preventative care, productivity, and well-being for rural workers—demonstrating that even simple modifications to traditional tools can have significant public health and societal benefits.

### Case Study 11 – Levelling the Field: Sivasoorya's Solar Solution

S.A. Sivasoorya, Chennai,  
Tamil Nadu

Granted Patent No: 420142

S.A. Sivasoorya from Chennai, Tamil Nadu, developed a solar-powered field leveller designed specifically for small paddy and cotton growers who lack access to expensive mechanized equipment and as traditional animal-powered methods become unsustainable. The innovation integrates photovoltaic modules and a motorized drive, supporting customizable attachments for various crops, thereby offering versatility across half-acre to five-acre plots and for both wetland and dryland applications. By using solar energy, the leveller eliminates reliance on fossil fuels, reducing operational costs and environmental impact, while swappable implements enable flexible, multi-season use.



*Solar wetland leveller and trimmer*

Sivasoorya's device thus democratizes mechanization for resource-limited farmers, promoting economic and ecological sustainability and exemplifying how youth-led, scientifically informed design can bring transformative efficiency and equity to rural agriculture.

### Case Study 12- Spray Safe: The Smart Pesticide Pump That Cares

Parth Patel, Aditya Chauhan,  
Rohit Manavadiya and Jaydip Raval, Gandhinagar, Gujarat  
Granted Patent No: 507248



*Spray pump with mandatory mask*

Pesticide application poses serious occupational hazards in agriculture, with smallholder farmers frequently at risk due to inadequate use of personal protective equipment (PPE) and a lack of enforced safety measures, resulting in increased incidents of poisoning, respiratory illness, and chronic health disorders. To address this, Parth Patel, Aditya Chauhan, Rohit Manavadiya, and Jaydip Raval from Gandhinagar, Gujarat, developed a pesticide spray pump featuring an integrated interlock safety system that utilizes detection technology to ensure operation is only possible when the user is wearing a protective mask. If the mask is absent, the device locks, thereby automating compliance with critical safety protocols and mitigating the limitations of voluntary PPE usage in rural contexts. By combining essential protective functions within a standard spraying tool

without added cost or complexity, this innovation substantially reduces chemical exposure, promotes widespread adoption of good safety habits, and places occupational health at the forefront of agri-technology illustrating how practical, user focused engineering can greatly improve farmer safety and well-being in resource-constrained environments.

### **Case Study 13 - Nutcracker Unleashed: Portable Solutions for Chironji Processing**

Indrajeet Singh, West Singhbhum, Jharkhand

Granted Patent No: 498062



*Low cost portable Chironji decorticator*

Chironji (*Buchanania lanzan*) kernels offer both culinary and medicinal value, but their extraction from hard shells has traditionally been a highly labor-intensive, inefficient manual process-typically involving stone rubbing or pounding-resulting in extensive kernel breakage and yield losses nearing 80%, particularly impacting small and tribal farmers in remote forested regions such as in Jharkhand. To address these challenges, Indrajeet Singh developed a portable decorticator engineered for cost-effective, efficient operation, accommodating both manual and solar power to ensure off-grid accessibility. The device incorporates a hopper for regulated

seed intake, abrasion surfaces for effective shell removal, and a grading unit for separation of kernels from shells and dust, greatly improving recovery rates while reducing labor and kernel damage. By mechanizing chironji nut processing, this innovation transforms a laborious task into a viable micro-enterprise for rural communities, increasing processing efficiency, clean kernel yield, and income-thereby enhancing livelihood opportunities and promoting sustainable utilization of valuable forest products in economically challenged areas.

### **Case Study 14 - Cutting Time in the Cabbage Field: Yash's Cole Crop Harvester**

Yash Pramod Jadhav, Pune, Maharashtra

Granted Patent No: 513026

Yash Pramod Jadhav from Pune, Maharashtra, addressed the ergonomic and productivity challenges of harvesting cole crops such as cabbage, cauliflower, and broccoli by designing a manual harvesting device that reduces the repetitive strain and inefficiency inherent in traditional methods, which require constant bending and manual cutting. Inspired by firsthand experience in the field, he engineered a user-friendly tool equipped with a sharp cutting blade, ergonomic handle, and a mechanism that allows rapid and clean detachment of crop heads from the plant in one motion. This innovation enables farmers to progress systematically along rows, minimizing physical fatigue and heavy lifting while

greatly improving harvesting speed and the quality of produce. By offering an affordable, efficient, and easy-to-use solution, Yash's tool enhances marketable yields, increases smallholder income, and exemplifies grassroots engineering that advances both productivity and work dignity within labor-intensive rural agricultural operations.



*Cole Crop Harvester*

### **Conclusion**

The case studies presented here underscore the remarkable ability of India's student innovators to address enduring agricultural challenges through scientifically grounded, low-cost, and user-centric solutions. Drawing on principles from engineering, ergonomics, and biological sciences, these young inventors have developed practical devices - ranging from solar-powered threshers and crop-specific harvesters to integrated safety tools and bio-fertilizer innovations - that effectively tackle labour bottlenecks, occupational hazards, and resource inefficiencies faced by small and marginal farmers. Collectively, their efforts demonstrate how grassroots science and creativity, when shaped by local context, can serve as a powerful catalyst for advancing agricultural productivity, sustainability, and rural livelihoods across India. ■

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# Building Grassroots Innovation Ecosystems in Southern Bastar Region, Chhattisgarh

Rahul Prakash, Nitin Maurya, Vivek Kumar

In today's rapidly evolving world, innovation has become essential for sustainable development and economic growth. Yet, marginalised communities often remain excluded from mainstream innovation processes. Recognising that actual development must harness local creativity and traditional knowledge systems, the National Innovation Foundation-India (NIF) has been implementing comprehensive initiatives across the Bijapur, Sukma, Dantewada, and Bastar districts in Chhattisgarh's southern Bastar region to build and strengthen grassroots innovation ecosystems. These aspirational districts, with their rich indigenous knowledge and unique local challenges, present both opportunities and necessities for cultivating innovation ecosystems that can drive self-reliant development while preserving traditional wisdom.

NIF has developed a systematic approach that recognises immense creativity among tribal students and local innovators who have been solving problems for generation. The institution's strategy encompasses four core areas: fostering student innovation through structured programs, documenting traditional knowledge and grassroots innovations, engaging communities through exhibitions and outreach initiatives, and disseminating grassroots

technologies. This comprehensive framework aims to create self-sustaining innovation network that preserve traditional wisdom while addressing contemporary challenges through locally relevant solutions.

## Unleashing Students' Creativity

NIF has demonstrated remarkable success in fostering student creativity through various programs. Through the IGNITE campaign (until 2019), NIF successfully mobilised thousands of student technological ideas across the region, with support from the Rajiv Gandhi Shiksha Mission (Samagra Shiksha Abhiyan) and non-governmental organisations like Shiksharth and Bachpan Banao in the area.

This initiative produced three national-level winners, viz. Bharat from Dantewada for his 'Machine to pluck Tendu leaves', Indu

Manikpuri from Dantewada for her 'Septic tank level and pressure indicator' and Roshan Sodi from Sukma for his 'Real-time data transmission system in electronic voting machines'.

NIF currently engages students (class 6-12) through the INSPIRE MANAK program in collaboration with the Department of Science and Technology, Government of India. In 2023, Nidhi Shrivastava from Dantewada received recognition at the National Level Exhibition and Project Competition for her "Multipurpose Husk Removal Machine for Domestic Purpose." NIF provides comprehensive support to nationally recognised ideas through prototype development and patent filing processes, demonstrating towards institution's commitment to nurturing innovation among young minds.



Bharat demonstrating his 'Machine to pluck Tendu leaves' during Dr. APJ Abdul Kalam IGNITE Award Exhibition 2015.



*Documentation of traditional knowledge through field visit*

## Knowledge Preservation through Documentation

Parallel to student programs, NIF conducts systematic scouting activities through workshops, exhibitions, and field visits to document grassroots innovations and outstanding traditional knowledge. The institution has organised various herbal healer workshops in collaboration with the Forest Division of Bastar and Dantewada, documenting over 500 traditional knowledge practices while identifying technological challenges for improved dissemination strategies. NIF maintains continuous engagement through field visits by teams and interns across the region, conducting sensitisation programs with universities and targeted meetings with mechanics, fabricators, and progressive farmers to scout and document engineering and agriculture-based innovations. Recently, in May 2025, a similar workshop was organised at Jagdalpur in collaboration with various stakeholders.



*Workshop for scouting and documentation at Jagdalpur, Bastar*

This systematic approach creates a comprehensive repository that bridges indigenous knowledge and modern technological applications while ensuring complete coverage of local knowledge systems. The knowledge collected is screened to identify novel practices that could be taken up for scientific validation.

## Technology Dissemination and Implementation

The cornerstone of NIF's work lies in the systematic dissemination of technological innovation, which has undergone significant evolution from 2018 to 2025 in the region.



*Dissemination of incense stick making machine at Dantewada*

The initial phase, in May 2018, introduced cow dung pot-making machines to 30 participants at Aasna Nursery in Jagdalpur and trained over 100 women from 14 Self-Help Groups on bamboo processing and multi-seed decorticators at Nangur village, with the forest division providing bamboo supplies and market linkages. Sanitary napkin-making units were established at Ekta Mahila Gram Sangathan Bhavan in Chitalur village, Dantewada, where 10 women from different Self-Help Groups participated in comprehensive awareness sessions on menstrual hygiene & training on the machine. The administration established buy-back systems and packaging arrangements. By December 2020,

this unit had evolved with upgraded automatic machines and sustainable profit generation, thanks to the support of the National Rural Livelihood Mission BIHAN district team and National Mineral Development Corporation.

The second phase (2019-2021) focused on the Bijapur district, with the dissemination of sanitary napkin units at BIHAN Bazar, facilitated by the district administration with the support of the CEO of Zila Panchayat. A complete Triphala manufacturing unit was established at the Multi Utility Centre in November 2021. This comprehensive integrated project introduced four technologies for processing local Amla (*Phyllanthus emblica*), Harada (*Terminalia chebula*), and Baheda (*Terminalia bellirica*) fruits. The latest technology dissemination phase in 2025 brought significant advancements, with innovative Leaf Plate Making Machines installed in Chitalur and Dhurli Gram Panchayats. This initiative trained 22 tribal women, who now have production capacities of 600 plates and 800 bowls per hour. Later, an Automatic Ultra-Thin Sanitary Napkin Machine with a UV Conveyor was introduced in Dantewada district, capable of producing UV-sterilised 30-40 sanitary napkin pads per minute.



*Setting up of Multi-Spice Grinder at Bijapur in Triphala making unit*



## Community Engagement

Before embarking on any significant activity, it is important to engage with communities at the grassroots level to understand their needs and aspirations truly. This approach moves beyond simply “doing for” a community and instead focuses on “doing with,” empowering local voices and ensuring the interventions have a lasting impact. The most comprehensive community engagement initiative by NIF was the Innovation Yatra, an 11-day program organised across 14 states that achieved significant impact in Bastar (August 7-9, 2023). This initiative reached over 1,000 participants across aspirational districts, with notable achievements including 140 women students at Government Danteshwari Mahila Mahavidyalaya and over 700 attendees at Atal Bihari Vajpayee

Education City, which enabled to document technological ideas, innovations, and knowledge practices from them.

**Before embarking on any significant activity, it is important to engage with communities at the grassroots level to understand their needs and aspirations**

During the yatra, training was provided to more than 20 Self-Help Group members for making sanitary napkins through grassroots innovations. This was built upon earlier outreach efforts during December 2020 and January 2021, which included SHG

training programs, on grassroots innovation and documentation of traditional knowledge practices.

Earlier, NIF engaged at the grassroots by participating in various exhibitions and other events. For example, NIF participated in India's first Tribal Entrepreneurship Summit in Dantewada (November 2017), organised by NITI Aayog in collaboration with the Ministry of Tribal Affairs, featuring innovators like Mansukhbhai Prajapati with Mitticool innovations, DV Chouhan with a multi-seed decorticator, and Sheikh Afzal with low-cost sanitary pad-making machine.

Regular participation in regional exhibitions showcases green, grassroots technological innovations, inspiring creative thinking and the adoption of innovation for community empowerment.



*Innovation Yatra in the Southern Bastar region*

## Impact and Future Outlook

NIF's multi-year efforts are yielding tangible outcomes across the region, with communities actively engaged in innovation-based livelihood activities. Over 200 women have been trained in various technology applications, from sanitary napkin production to NTFP processing, creating sustainable income sources. The documentation of 500+ traditional practices has preserved invaluable indigenous knowledge while creating pathways for modern applications. Student innovators have garnered national recognition through patent grants, showcasing the region's emerging young technological talent.



*Showcasing Grassroots Innovations at Tribal Entrepreneurship Summit*

Key technologies have reached remote villages, improving daily life through practical solutions such as head-load Reducer, which

reduce drudgery for tribal women, natural water coolers that provide public relief, and herbal mosquito repellents that offer locally produced health solutions. The Dantewada sanitary napkin unit's evolution from a manual operation in 2018 to an automated facility by 2025 exemplifies how sustained support builds local manufacturing capabilities and generates consistent employment opportunities.

NIF has not only introduced these innovations but also continuously supports beneficiaries in the sustainable operation of all these units. In line with this commitment, NIF recently organised the workshop "Grassroots Innovations – Assessing Impact, Spread and Shared Learning in Eastern Region", where beneficiaries from all these regions participated in capacity building sessions while sharing the impact of these interventions. This ongoing support ensures long-term sustainability and creates opportunities for peer learning and knowledge exchange among communities, ultimately empowering marginalised communities to become self-reliant innovation hubs where

local knowledge drives economic development and unlocks transformative potential for broader regional prosperity.

## Acknowledgement

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# Women-Led Enterprise Development for Viksit Bharat @ 2047

Poonam Singh, Tushar Garg

**W**omen, who constitute nearly half of India's 1.45 billion population, are vital pillars of national reconstruction, growth, and development. This article argues that the vision of Viksit Bharat will be realised not only through the success of large-scale industries but also through enhanced everyday productivity, where Women-Led Enterprises (WLEs) play a pivotal role. The major contributions of WLEs include, but are not limited to, generating steady secondary incomes, improving household decisions on education and nutrition, and transforming traditional and local skills in food, craft, care, and services into marketable products.

India now possesses robust public data infrastructure to monitor this progress at scale—employment through the Periodic Labour Force Survey (PLFS), enterprise identity via the Udyam Portal and Udyam Assist Platform (UAP), market access through the Government e-Marketplace (GeM), seamless digital payments via UPI, and local vulnerability data through multiple public platforms. Recent trends reinforce this trajectory: female labour force participation has risen steadily since 2017–18; gender-tagged MSME registrations are substantial and expanding; UPI has significantly reduced transaction frictions; and women sellers are increasingly active on GeM as well as leading e-commerce platforms such as Amazon,

Flipkart, and Myntra, among others.

## Introduction

The Viksit Bharat as a clarion call by the Hon'ble Prime Minister will ultimately be realized through a combination of productive capacity, economic resilience, and skill oriented power of millions of Indian households.

This transformation will witness crucial role played by women-led enterprise (WLE), diversifies household income streams beyond precarious labor wages, generates positive influences on educational and nutritional status, and transforms local knowledge into commercially viable economic activity. India has strengthened its administrative and data infrastructure necessary to monitor these dynamics. Labor market trends are documented through Periodic Labour Force Survey (PLFS); enterprise formalization is tracked via Udyam

portal and Udyam Assist Platform (UAP); market transactions are recorded on the Government e-Marketplace (GeM) and Open Network for Digital Commerce (ONDC); financial flows are captured in UPI payment data; and environmental stressors viz., rainfall variability and temperature extremes can be measured at high spatial resolution through Indian Meteorological Department (IMD) systems. This integrated data architecture enables holistic development outcomes. A key advantage offered by the Digital Public Infrastructure (DPI) is that one need not necessarily move from one location to other so as to engage in a commercial activity. It can still be accomplished from one's base location and it offers a never before opportunity for women of our country to participate in economic activities that fuel the nation. For example, the cottage industry which are often driven from one's home now

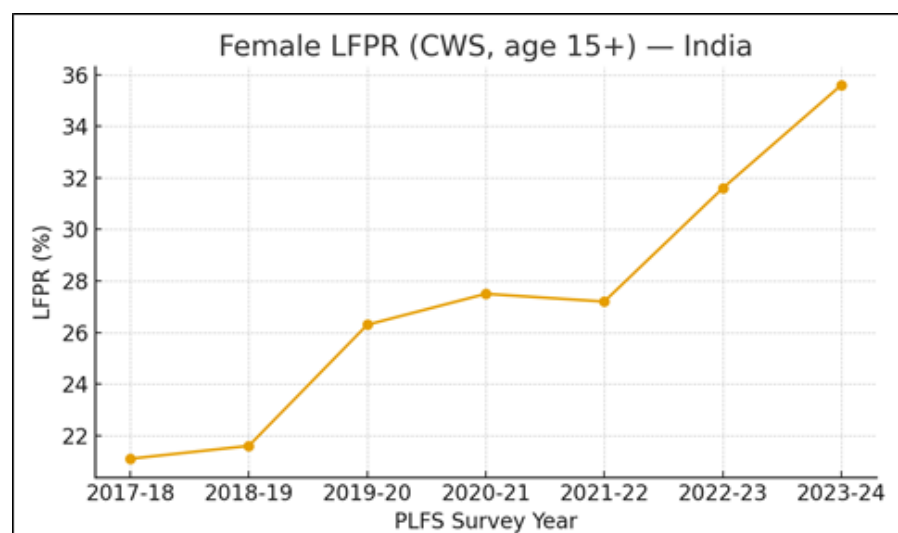


Figure 1. Female LFPR (Current Weekly Status, 15 or above age group), 2017–18 to 2023–24 (MoSPI, PLFS Press Note, 23 Sep 2024).

have a plethora of marketplaces to sell their products, and digital payments make revenue collection geography independent. As result, not only women attempt participation but also remain hooked to it as the process is not impacting their parallel responsibilities in any adverse manner. While on one side they are able to take care of their family, on the other they also contribute through their professional excellence, which was waiting to be harnessed.

### Increasing Women's Economic Participation

The most significant underlying trend is the measurable increase in women's labour force participation. According to the PLFS, the female Labor Force Participation Rate (LFPR) for persons aged 15 and above rose from 21.1% in 2017–18 to 35.6% in 2023–24, reaching 39.7% in rural areas and 26.1% in urban centres (Figure 1)[1]. This upward trajectory fundamentally expands the potential for enterprise formation and self-employment among women.

Progress is equally visible in formal enterprise registration. As of September 30, 2025, the MSME dashboard records 6.90 crore registrations under the Udyam portal and UAP platforms in which

4.15 crore are identified as male-led, 2.72 crore as female-led, and 2.60 lakh as other categories[2]. This gender-disaggregated registry provides a concrete basis for targeted performance measurement and policy intervention.

Digital payment infrastructure has further reduced transaction barriers. In August 2025 alone UPI processed over 2,000 crore transactions worth ₹24.85 lakh crore[3], creating frictionless settlement mechanisms crucial for MSME operations. Public procurement has also become more inclusive. Women entrepreneurs now constitute approximately 8% of GeM seller base, with 1.78 lakh Udyam-verified women MSMEs having fulfilled cumulative orders worth ₹46,615 crore[4]. This demonstrates a functioning pathway from registration to actual market transactions.

Collective institutional capacity is expanding as well. As of June 2025, the Deendayal Antyodaya Yojana–National Rural Livelihoods Mission (DAY-NRLM) encompasses approximately 90.9 lakh women's self-help groups with 10.05 crore members nationwide[5]. Together, these data points provide concrete evidence of functioning systems for market entry, access, cash flow,

and experiential learning contributing to women empowerment.

### Challenges and Opportunities

Women-led firms reshape local economic structures through three interconnected mechanisms. First, they diversify household income portfolios. Even modest but regular enterprise earnings reduce household vulnerability to agricultural weather shocks and volatile casual wage markets, particularly critical in rain-dependent areas with limited non-farm employment opportunities. Second, they localize value chains. Neighborhood-based enterprises, for instance, cloud kitchens, tailoring units, repair services, or food processing operations, etc., procure raw materials locally and retain profits within the community, strengthening regional economic circulation. Third, they commercialize cultural and tacit knowledge. Women often possess specialized knowledge in crafts, regional cuisines, herbal wellness, and care services rooted in community beliefs and intergenerational learning. However, this knowledge may remain economically invisible in the absence of standardized packaging, catalog development, reliable distribution networks and outreach.

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These productive channels face recurrent challenges. Women entrepreneurs typically lack titled property for collateral, forcing reliance on high-interest informal credit for small loans. They operate with limited buyer networks and face mobility restrictions that constrain market reach. The “double burden” of unpaid care work and domestic responsibilities compresses available enterprise time. Training programs often emphasize regulatory compliance over product strategy, pricing, or sales techniques. Additionally, women face persistent information asymmetries about available support systems and market opportunities.

Importantly, these constraints are solvable. Evidence shows that wherever governments have created streamlined registration pathways (Udyam/UAP), frictionless payment systems (UPI), accessible buyer platforms (GeM/ONDC), invoice financing options through Trade Receivables Electronic Discounting System (TReDS), and practical support for care responsibilities and mobility, women-led enterprises demonstrate significantly improved WLE survival outcomes.

In addition to credit disbursal, the organization of predictable market structure is critical to ensure viable WLE businesses because without streams of regular buyers such businesses would not sustain. Large institutional buyers e.g., government canteens, schools, hospitals, and departmental procurement offices, etc., provide



*AI generated image*

dependable, recurring demand. To make this accessible to small enterprises, procurement should be restructured and published in regular purchase calendars in advance. This allows women-led units to plan production and commit resources confidently. When enterprises have confirmed orders, credit becomes productive rather than speculative. Furthermore, childcare and transportation directly determine how many hours women can dedicate to their enterprises. Practical solutions include: properly functional on-site childcare at common facility centres (creche), training schedules, safer and robust transportation options. These investments directly increase productive capacity.

### Conclusion

WLE constitutes a fundamental component of the Viksit Bharat vision, representing a primary pathway toward more resilient and

capability based socio-economic development. Female labor force participation rates have demonstrated sustained increases in official PLFS data; women’s entrepreneurial activity has gained measurable prominence in enterprise registries; the UPI has substantially reduced transaction costs for small-scale commerce; and the GeM has established that public procurement systems can effectively channel demand toward women-led enterprises at scale. systematic implementation and coordination will position women as economic producers rather than welfare recipients.

Through prioritized capability infrastructure, monitoring system, women-led enterprise will extend beyond aggregate growth contributions. It will fundamentally transform the fabric of everyday economic participation, which represents the substantive meaning of “*Viksit Bharat.*” ■

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# Driving Sustainability through Grassroots Innovations - NIF and the 2030 Development Agenda

Shubhamika Jha, Anand Prakash Tiwari

The 2030 UN Agenda for Sustainable Development calls for balanced economic growth, societal well-being, and environmental protection, and Grassroots Innovations (GIs) fundamentally aim to achieve these very objectives by leveraging local knowledge, skills, and creativity. By promoting locally developed solutions grounded in community expertise, the National Innovation Foundation–India (NIF) has been at the forefront of advancing grassroots innovations to further the 2030 Agenda for Sustainable Development. In this context, this article examines the significance of grassroots innovations, presents illustrative examples, and aligns them with multiple relevant SDGs. Furthermore, we elaborate on NIF's contributions to sustainable agriculture, environmental stewardship, and rural development by positioning grassroots innovations as a core component in realizing both national and global development objectives.

## Introduction

GI typically emerges from resource-constrained settings where necessity drives creativity. They are inclusive, reflecting the lived experiences, materials, and practices of ordinary people, and sustainable, relying on efficient use

of local resources and promoting social empowerment. To fortify GIs infrastructure in India, NIF has created a unique ecosystem of handholding through an elaborate mechanism of scouting, documentation, validation, incubation, commercialization, Intellectual Property Rights (IPRs) protection, and diffusion in both domestic and global markets. These innovations contribute to the achievement of various Sustainable Development Goals (SDGs), including poverty reduction, quality education, clean energy, climate action, and sustainable communities[1].

## Societal and Environmental Imperatives

The distinction of grassroots innovations lies in their dual impact: they address social needs while reducing environmental challenges. For marginalized and rural communities, these innovations fill major gaps that mainstream markets often overlook. A farmer designing a low-cost agricultural tool, a villager making an eco-friendly herbal pesticide, or an artisan creating toys with herbal colours from plant extract all follow this principle. They empower communities that have been traditionally excluded from global technological advancements, and hence their impact is directly

linked to inclusion and participatory development.

## GIs and SDG Linkages: Few Examples

One significant example is the Mitticool refrigerator, developed by Mansukhbhai Prajapati, a grassroots innovator from Gujarat. This refrigerator, made of clay, works without electricity and keeps food fresh for several days. It is particularly beneficial for rural households where the electricity supply is irregular. As an innovation, it demonstrates environmental sustainability by utilizing natural cooling while reducing carbon footprint[2].



The Bureau of Indian Standards (BIS), the National Standards Body of India, has developed an Indian Standard, IS 17693:2022, for non-electric cooling cabinets made of clay. And this innovation directly aligns with SDG 1 (No Poverty), SDG 2 (Zero Hunger), SDG 5

1. <https://sdgs.un.org/goals>

2. <https://nif.org.in/innovation/mitti-cool-refrigerator/751>

3. <https://www.pib.gov.in/PressReleasePage.aspx?PRID=1834548>



(Gender Equality), SDG 7 (Affordable and Clean Energy), SDG 9 (Industry, Innovation and Infrastructure), and SDG 12 (Responsible Consumption and Production) because it promotes preserving food without electricity, supports nutrition, reduces food wastage, promotes sustainable technology, and encourages eco-friendly consumption patterns[3].

Another example is the HRMN-99 apple variety, developed by a farmer innovator, Hariman Sharma from Himachal Pradesh, which can grow in lower altitudes and warmer climates where traditional apples would fail. This innovation makes apple farming feasible in non-traditional regions by increasing livelihood opportunities and enhancing agricultural resilience in the face of climate change. It aligns with SDG 1 (No Poverty), SDG 2 (Zero Hunger), SDG 8 (Decent Work and Economic Growth), SDG 9 (Industry, Innovation and Infrastructure), SDG 12 (Responsible Consumption and Production) and SDG 13 (Climate Action) as it improves rural incomes, food security, agricultural innovation, sustainable farming, and climate resilience, benefiting farmers and expanding apple cultivation beyond traditional regions [4].



**HRMN 99 Apple**

A third example is the Modified Hydro Electricity Turbine by G K Ratnakar from Karnataka is a grassroots innovation addressing rural energy challenges by harnessing the power of flowing streams to generate electricity efficiently in hilly regions. This renewable, pollution-free, and cost-effective technology directly aligns with SDG 7 (Affordable and Clean Energy), SDG 13 (Climate Action), and SDG 6 (Clean Water and Sanitation), which promotes access to reliable, sustainable, and modern energy for all by supporting clean energy initiatives, helping reduce greenhouse gases, and promoting sustainable water utilization [5].



**Modified Hydro-Electric Turbine**

Similarly, Banana fibre products, developed by P.M. Murugesan from Tamil Nadu, utilize banana stem waste and extract fibers to create sustainable, biodegradable alternatives such as bags and baskets. This innovation aligns primarily with SDG 12 (Responsible Consumption and Production), SDG 8 (Decent Work and Economic Growth), SDG 9 (Industry, Innovation, and Infrastructure), SDG 5 (Gender Equality), and SDG 15 (Life on Land) since it advances sustainable practices in manufacturing, reduces waste, and supports eco-friendly product

development. Additionally, it supports rural livelihoods and community empowerment through resource-efficient production.



**Banana Fiber Products**

The herbal formulation Kamaal 505 by Ishwar Singh Kundu from Haryana promotes the sustainable use of terrestrial ecosystems and supports biodiversity conservation. Kamaal 505 acts as a bio-fertilizer and soil enhancer, improving soil fertility, increasing water retention, and offering an eco-friendly alternative to synthetic inputs. By reducing the reliance on chemical pesticides and fertilizers, this innovation helps combat land degradation, enhances crop yields and sustainable agriculture, and healthier agro-ecosystems, directly supporting the SDG 2 (Zero Hunger), SDG 12 (Responsible Consumption and Production), and SDG 15 (Life on Land) of protecting terrestrial habitats and halting biodiversity loss [6].



**Kamaal 505**

3. <https://www.pib.gov.in/PressReleasePage.aspx?PRID=1834548>

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6. [https://nif.org.in/innovation/herbal\\_formulation\\_kamaal\\_505/364](https://nif.org.in/innovation/herbal_formulation_kamaal_505/364)

## India's Approach Towards the Agenda 2030

India has shown a strong national commitment to advancing the Agenda 2030 Sustainable Development Goals (SDGs). As the world's largest democracy and home to nearly one-sixth of humanity, India's approach is anchored in an inclusive, whole-of-government, and whole-of-society approach led by NITI Aayog and supported by various ministries, state governments, and development partners, ensuring that "no one is left behind". Key initiatives such as the Pradhan Mantri Jan Dhan Yojana (financial inclusion), Swachh Bharat Abhiyan (sanitation), Jal Jeevan Mission (rural water supply), National Solar Mission (renewable energy), PM Ujjwala Yojana (clean air), Ayushman Bharat (health), and the Digital India Mission and the Aspirational Districts Programme etc., have been mapped directly to SDG outcomes and aim to bridge development gaps, promote equity, and foster sustainable livelihoods. [7] By 2025, India has moved into the top 100 nations for SDG performance, ranked 99th out of 167 countries, reflecting progress in areas like access to electricity, clean cooking fuels, and banking, while reporting challenges in water stress management, environmental sustainability, and urban pollution [8]. Also, India is scaling up climate action via the Mission Lifestyle for Environment (LiFE), and the National Action

Plan on Climate Change (NAPCC) and afforestation programmes, while strengthening peace, justice, and institutions through initiatives like Digital India and expanded legal access. Alignment of SDGs with India's longer-term Viksit Bharat @2047 vision highlights integrated strategies bridging inclusion, innovation, and robust institutions, setting the foundation for a developed nation by the centenary of independence. Through various policies, multi-stakeholder engagement, and global cooperation, India is working to transform the Agenda 2030 into a concrete and lasting national movement [9].

### Grassroots Innovations and Sustainable Development Goals

By reducing drudgery, enhancing productivity, empowering women, and promoting renewable materials, GIs contribute effectively to SDG goals such as:

**SDG 1: No Poverty** - by increasing livelihood opportunities through local innovations.

**SDG 2: Zero Hunger** - via agricultural innovations that improve productivity and climate resilience.

**SDG 5: Gender Equality** - as many grassroots innovations reduce the labour burden on women and encourage participation.

**SDG 7: Affordable and Clean Energy** - through renewable rural electrification solutions.

**SDG 8: Decent Work and Economic Growth** - by generating

livelihoods and work opportunities that raise inclusive economic growth.

**SDG 9: Industry, Innovation, and Infrastructure** - by building local-level technological alternatives.

**SDG 12: Responsible Consumption and Production** - through eco-friendly technologies that cut resource use.

**SDG 13: Climate Action** - by promoting adaptive practices and energy-efficient technologies.

**SDG 15: Life on Land** - by promoting eco-friendly solutions that conserve biodiversity and manage natural resources.

### Conclusion

GIs highlight a fundamental truth of life: innovation is not the exclusive domain of advanced regions or laboratories, but equally resides in villages, farms, and households. In this context, NIF illustrates how grassroots innovations can be aligned with the global 2030 Agenda for Sustainable Development [10]. GIs also embody the capacity of peripheral communities to engage directly with the challenges of sustainability and social inclusion. Their transformative potential is evident in their adaptability, affordability, and cultural resonance. Therefore, by connecting local creativity with national and international development benchmarks such as the SDGs, grassroots innovations offer democratic and participatory pathways for human development. ■

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# Empowering Farmers through Knowledge Exchange - On-Farm Interaction at Disang Chapori, Sivasagar, Assam

Rajiv Mili, Sayed Abdul Hai

In India's agrarian landscape, where smallholder farmers constitute the backbone of rural livelihoods, knowledge exchange has become a pivotal force in driving sustainable development. Farming today extends far beyond the traditional practices of tilling land or sowing seeds-it now entails navigating market fluctuations, adapting to climate variability, managing pests and diseases, and innovating across value chains to enhance productivity and income. Within this evolving context, grassroots innovations and collaborative learning platforms have gained recognition as vital lifelines, empowering farmers to share experiences, discover solutions, and collectively forge pathways toward resilience.

In this spirit, a one-day farmers' interaction program was held on June 1, 2025, at Disang Chapori in the Sivasagar district of Assam. Facilitated by the National Innovation Foundation (NIF) – India, an autonomous institute of the Department of Science and Technology, Government of India, the event sought to engage local farmers, document distinctive agricultural practices, and introduce innovations that bridge traditional wisdom with modern science. What unfolded over the course of the day was far more than an outreach initiative-it was a living reflection of the challenges, aspirations, and immense untapped potential of Assam's rural farming communities.

## The Setting: Disang Chapori and Its Agricultural Identity

Disang Chapori is a fertile floodplain shaped by the river Disang, a tributary of the Brahmaputra. The landscape, while agriculturally productive, remains vulnerable to periodic floods, pest outbreaks, and market fluctuations. Farmers in this region cultivate a range of crops, predominantly vegetables such as lady's finger, brinjal, chilli, cabbage, tomato, Indian mustard, cucumber, and white gourd etc.

These crops not only ensure food security at the household level but also sustain weekly village markets and, in exceptional cases, enter export supply chains.

The program drew the participation of 50 farmers representing diverse agricultural backgrounds, including cultivators, cowherds, milkmen, and pastoralists. Their voices reflected the multiple dimensions of farming such as economic, ecological, and social etc. that converge in rural Assam.

Table 1. Key Challenges Faced by Farmers in Disang Chapori

| Farmer                     | Primary Concern                          | Details Reported                                                                 | Broader Implication                         |
|----------------------------|------------------------------------------|----------------------------------------------------------------------------------|---------------------------------------------|
| Dinesh Taye                | Market linkage & crop infections         | Lack of access to remunerative markets; microbial infections in chilli & brinjal | Financial losses; vulnerability to pests    |
| Gojen Pangging             | Price crash in cucurbits & crop diseases | Cucumbers at ₹3–8/kg; white gourd price crash; ridge gourd curling issue         | Economic unsustainability; declining yields |
| Subhash Chandra Mala       | Post-harvest losses                      | Poor storage, handling & transport; large-scale wastage of vegetables            | Reduced income; food insecurity             |
| Other farmers (collective) | Price volatility & infrastructure gaps   | Inconsistent returns, limited aggregation, and weak bargaining power             | Lack of long-term livelihood stability      |



Dissemination of herbal innovations such as Zenrelax, MASTIRACK etc.

## Farmer Voices: Challenges from the Ground

The participatory group discussion revealed a series of interrelated concerns. These are summarized in Table 1, which lists farmers' experiences into specific challenges and broader implications.

## The Price Trap and Market Linkages

Farmers such as Dinesh Taye and Gajen Pangging highlighted how the absence of reliable market linkages leaves them at the mercy of fluctuating prices. The "price trap" is stark: while cucumbers may fetch a modest ₹5–8 per kilogram, prices often plummet to as little as ₹3/kg during peak harvests. Such volatility undermines the very sustainability of vegetable cultivation. This mirrors a national challenge, where smallholder farmers, lacking aggregation centers or bargaining power, are often forced into distress sales.

## Crop Health and Pest Pressures

For farmers in the region, the struggle doesn't end at planting; it

begins in earnest when crops face pests and diseases. Buddhi Dahal, a brinjal grower from a small village, recalls losing nearly half his yield to bacterial wilt last season. Similarly, chilli cultivators like Chitrabati Pangging report repeated outbreaks of leaf curl and fruit rot, which not only devastate production but also shrink the market value of their harvests. Ridge gourd farmers, too, struggle with early leaf curling and stunted growth, often linked to viral infections transmitted by pests such as whiteflies. These experiences underscore how fragile smallholder farming can be: even a minor outbreak can quickly escalate into significant loss.

A major challenge lies in farmers' limited access to scientific advisory services. Many continue to depend on traditional knowledge or resort to reactive pesticide use, often applying chemicals only after visible crop damage. While this approach is understandable, it can further harm crop health, promote pesticide resistance, and disrupt populations of beneficial insects. The lack of structured Integrated Pest Management (IPM) frameworks leaves farmers

without preventive measures or systematic guidance. IPM techniques—such as crop rotation, use of biological control agents, pest-resistant varieties, and regular monitoring—can significantly reduce losses, yet remain underused due to insufficient training and awareness.

The response of these farmers highlight a pressing need for practical, on-the-ground solutions. Timely extension services, accessible diagnostic tools, and hands-on IPM training can empower farmers to anticipate and manage pest and disease outbreaks more effectively. Community-based initiatives, such as farmer field schools or cooperative monitoring programs, provide platforms for knowledge exchange, early detection of threats, and collective action to protect crops.

Addressing crop health challenges has benefits beyond improving yields. Reducing the indiscriminate use of chemicals helps protect the environment and sustain biodiversity. Strengthening farmer knowledge and resilient cropping systems enhance economic stability, ensure a steady supply of quality produce, and contribute to food security.



Cucurbits on Trellises and early harvesting of vegetable crops due to flood





*Bitter gourd crop affected by flood*

For farmers like Buddhi and Chitrabati, these interventions could mean fewer lost crops, higher incomes, and less anxiety over unpredictable pest outbreaks.

Ultimately, bridging the gap between scientific research and practical farming is essential. By

combining modern agronomic knowledge with local expertise, farmers can cultivate healthier, more productive, and resilient crops. Ensuring that crops thrive not only protect livelihood but also strengthen the entire food system, turning vulnerable smallholder

fields into model of sustainable agriculture. The discussions revealed potential interventions that could address farmer challenges if implemented systematically. Table 2 juxtaposes farmer concerns with possible solutions and their anticipated impacts.

Table 2. Farmer's Challenges and Suggested Solutions

| Challenge Category          | Farmer-Reported Issue                     | Suggested Solutions                                                          | Potential Impact                               |
|-----------------------------|-------------------------------------------|------------------------------------------------------------------------------|------------------------------------------------|
| Market Linkages             | Distress prices, lack of direct buyers    | Formation of FPOs, digital platforms, aggregation centers, contract farming  | Better price realization, reduced middlemen    |
| Pest & Disease Management   | Microbial infections, ridge gourd curling | Community plant clinics, IPM, disease-resistant varieties                    | Reduced crop losses, sustainable cultivation   |
| Post-Harvest Infrastructure | Spoilage due to poor storage/transport    | Solar dryers, cold storage, rural packhouses, linkages with processing units | Lower wastage, higher value realization        |
| Value Chain Development     | Lack of diversification & branding        | Processing cucumbers/white gourds, branding local produce, export support    | Income diversification, niche market capture   |
| Veterinary Issues           | Dairy cattle mastitis                     | Adoption of MASTIRAK, farmer training in livestock care                      | Improved animal health, reduced antibiotic use |



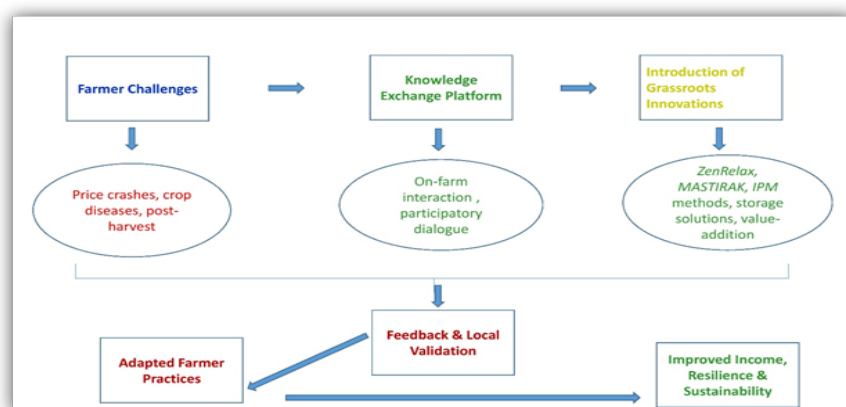


Figure 1. Innovation-Impact Pathway in Farmer Knowledge Exchange

## Post-Harvest Losses and Food Wastage

For Subhash Chandra Mala, farming was a new chapter after teaching-but the real battle begins after harvest. Without cold storage or proper transport, heaps of his fresh vegetables often rot before reaching the market. Every loss hits his income and feeds the region's hidden food wastage, in a place where nutrition is precious. Better storage, efficient logistics, and timely market access could transform these losses into opportunities, helping farmers like him thrive while more food reaches those who need it most.

## Resilience and Entrepreneurial Spirit

Despite systemic constraints, the farmers of Disang Chapori have demonstrated resilience. In recent years, they successfully exported cucumber and white gourd to Middle Eastern markets. While sporadic, this achievement underscores the entrepreneurial potential of rural farmers. With structured institutional support-such as farmer-producer organizations (FPOs), logistics networks, and branding initiatives-such successes could be scaled to transform the region into a hub for agri-exports.

In the second half, discussions were held about grassroots innovation and its applications, which were largely appreciated by the farmers.

## Conceptual Model of Knowledge Exchange

To understand how innovations translate into farmer empowerment, Figure 1 presents a conceptual framework of the innovation-impact pathway.

This model emphasizes that farmer empowerment emerges not from top-down technology transfer but from participatory validation, adaptation, and ownership of innovations.

## Critical Reflections: Beyond a One-Day Event

While the program in Disang Chapori was successful in creating dialogue, systemic gaps persist:

**Plant Health:** Farmers need access to low-cost diagnostic services and training in integrated pest management.

**Market Access:** Aggregation centers, cooperatives, and digital tools must be strengthened to prevent distress sales.

**Post-Harvest Infrastructure:** Cold storage and food processing units could convert losses into value-added products.

**Innovation Scalability:** Grassroots



An initiative for conservation of trees



Harvested chili for self consumption



Interactions with farmers



Field innovation with participants





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*Tree vegetation of the peripheral zone at farm*

innovations like Zenrelax\* and MASTIRAK\*\* require regulatory clearances, supply chains, and training for mass adoption.

Policy Backing: Long-term viability depends on institutional frameworks-credit, crop insurance, and rural infrastructure.

### Conclusion

The one-day interaction at Disang Chapori was more than a farmer outreach program; it was a participatory model of knowledge co-creation. By listening to farmers' voices, integrating grassroots innovations, and contextualizing solutions, the event showcased a pathway toward sustainable, farmer-centered agricultural development.

Yet, the true measure of success

lies not in a single event but in its follow-up. With systematic support, policy interventions, and grassroots innovation scaling, Disang Chapori could become a model for rural transformation in Assam - and by extension, in India's broader agricultural landscape. Finally, the program affirmed a critical truth: farmers are not just beneficiaries of innovation but active architects of

agricultural futures.

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\* *Human Health pain management*

\*\* *For Dairy Health*

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