SUNSHINE AGRICULTURE
e-Newsletter

ISSN (E): 2583 – 0821

Sun. Agri.:e- Newsletter, (2026) *6*(9), 65-68

Article ID: 666

Digital Villages, Inclusive Growth Harnessing Technology for Rural Transformation

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Open Access

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Available online at
www.sunshineagriculture.vitalbiotech.org

Article History
Received: 14.09.2026
Revised: 19.09.2026
Accepted: 24.09.2026

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INTRODUCTION

Agricultural extension has traditionally relied on a thin network of extension officers trying to reach millions of scattered farm households. The ratio of extension workers to farmers in India has long been inadequate, leaving large gaps in the timely flow of information on improved seeds, weather, pest outbreaks, and market prices. This gap is visible in connectivity data as well: according to the Telecom Regulatory Authority of India (TRAI), rural tele density and internet penetration continue to trail urban India by a wide margin, with rural internet subscribers per 100 population running at roughly half the urban rate even as rural connections grow faster year-on-year. Digital technology is now bridging this information gap in ways that were unimaginable a generation ago. Mobile-based advisory services, artificial intelligence-driven pest and disease diagnosis, drone-based crop monitoring, and e-market platforms are together creating a new extension ecosystem one that is faster, more personalised, and far more scalable than the conventional face-to-face model.

A farmer in a remote village can now receive a weather alert on her phone before a hailstorm strikes, upload a photo of a diseased leaf to get instant diagnosis, or check the day's mandi prices before deciding where to sell produce. These are not futuristic dreams; they are services already operating, though their reach and depth continue to expand.

Pillars of the Digital Village Model

The transformation of a village into a truly digital and inclusive space rests on several interconnected pillars, each of which has a direct bearing on how agricultural extension is delivered and received.

- **Connectivity infrastructure:** Affordable broadband and mobile networks under initiatives like Bharat Net are the foundation, without which no digital service can reach the last mile.

- **Digital literacy:** Training farmers, especially women and youth, to confidently use smartphones, apps, and online platforms so that technology becomes a tool of empowerment rather than exclusion.
- **Localised content:** Advisory and extension material in regional languages and voice formats, since text-heavy, English-only platforms often fail to reach less-literate users.
- **Data-driven agriculture:** Use of soil health cards, satellite imagery, and AI-based decision-support tools to give farmers precise, field-specific recommendations rather than generic advice.
- **Market linkages:** Digital platforms such as e-NAM and private agri-tech marketplaces that connect farmers directly to buyers, reducing dependence on intermediaries and improving price realisation.
- **Institutional convergence:** Coordination among Krishi Vigyan Kendras, Common Service Centres, Farmer Producer Organisations, and state agriculture departments to deliver services under one digital umbrella.

Emerging Technologies Reshaping Extension

Beyond these foundational pillars, a newer wave of technologies is beginning to deepen what digital extension can offer:

- **AI-based chatbots and advisory tools:** Conversational assistants that answer farmer queries in local languages, increasingly integrated into platforms like e-NAM and Kisan Call Centres for round-the-clock support.
- **IoT sensors for precision farming:** Low-cost soil-moisture, temperature, and weather sensors that feed real-time field data into irrigation and input-application decisions, reducing water and fertiliser waste.
- **Blockchain for supply-chain traceability:** Tamper-proof digital records that let buyers trace produces back to the farm, supporting quality certification and better price discovery for organic and export-oriented crops.
- **Satellite-linked crop insurance:** Remote-sensing and yield-estimation technology used under schemes like the Pradhan Mantri Fasal Bima Yojana (PMFBY) to speed up claim assessment and reduce disputes over crop-loss verification.

From Information to Empowerment: Real Impact on the Ground

The real strength of digital extension lies in converting information into empowerment. Weather-based agro-advisories have helped farmers time their sowing and harvesting more precisely, reducing losses from unseasonal rain. Mobile apps for pest and disease identification allow early intervention, cutting down on both crop loss and excessive pesticide use. Farmer Producer Organisations equipped with digital record-keeping and online marketing have negotiated better prices for their members. Women self-help groups, once at the periphery of agricultural decision-making, are increasingly using digital platforms to access credit, insurance, and government schemes directly, strengthening their role as active agricultural stakeholders rather than passive labour.

A Case in Point

The pattern repeats across states: individual farmers who once depended entirely on local traders report meaningfully higher realisation once they list produce on e-NAM instead of selling only in the nearest mandi, because the platform exposes their crop to buyers bidding from other markets rather than a single local price. With FPOs now also able to register and trade on e-NAM over 4,500 FPOs had done so by mid-2025 the benefit is increasingly reaching groups of small and marginal farmers

together, not just individual large holders, which is exactly the kind of collective bargaining power extension planners have long sought to build.

Common Service Centres and Krishi Vigyan Kendras have emerged as crucial touchpoints in this ecosystem. They function as hybrid spaces where digital tools are explained through human interaction a model that respects the trust farmers place in local institutions while introducing them to new technology. This blended approach, combining digital platforms with on-ground facilitation, has proved far more effective than technology deployed in isolation.

Challenges That Must Not Be Overlooked

The promise of digital villages is real, but so are the obstacles. The digital divide remains stark: connectivity is patchy in hilly, tribal, and remote regions; smartphone ownership and digital literacy are still lower among women, the elderly, and marginal farmers; and the cost of data and devices can be prohibitive for the poorest households. TRAI's own data illustrates the scale of this gap rural mobile and internet penetration continues to run at roughly half the urban rate even after several years of rapid rural growth. Language and design barriers persist, as many platforms are not intuitive enough for first-time users. There are also concerns about data privacy, the digital divide between large and small landholders in access to precision-agriculture tools, and an over-reliance on technology at the cost of traditional knowledge systems that have sustained farming communities for generations. Inclusive growth demands that these gaps be addressed proactively, not as an afterthought.

A Global Perspective

India's experience is part of a broader global movement in digital agriculture. Israel's precision-irrigation and sensor-driven farming systems have become a widely cited model for maximising yield per drop of water in water-scarce conditions. Kenya's mobile-money and SMS-based advisory ecosystems built around platforms comparable in spirit to mKisan have shown how even basic feature-phone technology can transform smallholder incomes when paired with trusted local intermediaries. China's rapid rollout of e-commerce platforms for rural produce offers a scale comparison for what an integrated market-linkage system like e-NAM could eventually achieve. Placed alongside these examples, India's digital village push stands out for its sheer scale and diversity of language and terrain, which makes the challenge of last-mile, vernacular-first delivery both harder and more important than in most peer economies.

The Road Ahead: Making Digital Extension Truly Inclusive

For digital villages to deliver genuinely inclusive growth, the focus must shift from mere technology deployment to people-centred design. Extension systems need to combine digital tools with continued human facilitation, ensuring that no farmer is left behind simply because she lacks a smartphone or cannot read a screen in English. Investment in last-mile connectivity, vernacular and voice-based interfaces, gender-sensitive digital literacy programmes, and stronger public-private partnerships will determine how deep and how equitable this transformation becomes. Agricultural universities, Krishi Vigyan Kendras, and extension functionaries have a vital role to play as trusted intermediaries who can translate digital possibilities into practical, trusted advice for every farm household.

Policy Recommendations

- **Subsidised connectivity and devices:** Expand low-cost data and device schemes targeted at marginal farmers and women-headed farm households, especially in hilly and tribal regions.
- **Vernacular-first, voice-enabled design:** Make regional-language and voice interfaces the default on all government agri-platforms, not an optional add-on.

- **Gender-focused digital literacy budgets:** Ring-fence funding within extension programmes specifically for training women and elderly farmers, who currently lag furthest behind.
- **Strengthen human-digital hybrid touchpoints:** Expand the role and staffing of Common Service Centres and Krishi Vigyan Kendras as the trusted face of digital extension.
- **Data privacy and farmer consent safeguards:** Build clear, farmer-understandable consent and data-protection standards into Agri Stack and other farmer-data platforms before scale-up.
- **Encourage public-private partnerships:** Incentivise agri-tech startups and private platforms to build for low-bandwidth, low-literacy contexts rather than urban-first design.

CONCLUSION

Digital villages are not an end in themselves; they are a means to a larger goal an agriculture sector that is more resilient, farmers who are better informed and better connected, and rural communities that share equitably in the country's growth story. When technology reaches the last farmer in the last village with the same ease as it reaches an urban household, rural transformation will have truly arrived, and inclusive growth will move from being an aspiration to a lived reality.

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