Agri Articles
(e-Magazine for Agricultural Articles)
Volume: 06, Issue: 05 (SEP-OCT, 2026)
Available online at http://www.agriarticles.com
©Agri Articles, ISSN: 2582-9882

From Field Visits to Virtual Advisories: The Rise of the Virtual Extension Agent

Sandeep Kumar, *Shubham Gaurav, Sonam Kumari and Aarni Singh
Ph.D. Scholar, Department of Agricultural Extension Education,
Bihar Agricultural University, Sabour, Bhagalpur (Bihar), India
*Corresponding Author's email: shubhamgaurav048@gmail.com

What if your extension agent could answer from your phone?

A crop is showing symptoms nobody in the household quite recognizes. Rain is forecast for tomorrow. The farmer needs advice today, not next week. In the traditional model, the next step is waiting for an extension officer to have time, transport, and a reason to visit that particular field. Now imagine a different sequence. The farmer records a short question on a phone. Sends it. Attaches a photo of the affected leaves. Within hours, an answer comes back sometimes from a person, sometimes from an automated system, sometimes from both working together. Is this the future of agricultural extension? In many places, it's already the present. This article looks at what a "virtual extension agent" actually is, what the evidence says it can and can't do, and why even as more of extension moves onto a screen trust remains a distinctly human thing.

What Is a Virtual Extension Agent?

The term sounds like it should mean one thing: an AI chatbot standing in for a human advisor. But based on the available evidence, it's broader than that. Virtual extension agents in agriculture encompass both automated digital platforms delivering advisory services and human extension agents operating through virtual communication channels (Sen et al., 2025; Byamukama et al., 2025; Klerkx, 2021). In other words, a virtual extension agent might be a fully automated advisory app or it might simply be your regular extension officer, reaching you by phone call, text message, or video call instead of a face-to-face visit. Digital extension services are described as transforming the agri-food sector by enhancing resource efficiency, environmental resilience, and economic viability for smallholder farmers, and as serving as a valuable source for learning and information exchange that helps create network collaboration among farmers and stakeholders while making service delivery more cost-effective (Sen et al., 2025).

Why Do We Need Virtual Extension?

Conventional extension systems were never designed for the scale and speed today's agriculture demands. Traditional extension systems, constrained by limited resources and outdated methodologies, often struggle to meet the dynamic needs of modern agriculture a gap that is motivating the shift toward ICT-enabled and virtual approaches (Khatri et al., 2024; Byamukama et al., 2025; Naika et al., 2021). This isn't a case for scrapping traditional extension. One extension officer can only visit so many farms in a week, and modern farming problems a fast-moving pest, a sudden price shift, a weather event don't always wait for a scheduled visit. Virtual extension is best understood as an additional channel, one that can help extension systems reach farmers faster and at a scale field visit alone cannot match.

The Farmer's Phone as an Extension Office

Several real-world models illustrate what this looks like in practice. These are documented examples from the literature not an exhaustive list of every virtual extension system in use, and their results shouldn't be assumed to generalize automatically to other contexts.

Ushauri, Tanzania. Farmers ask questions through an automated hotline; extension agents then respond through an online platform, and recorded answers can be reused for similar future questions, which reduces phone-call interruptions and frees up agent time for more complex cases (Ortiz-Crespo et al., 2020).

mKisan, India. A system delivering customized agricultural advice by SMS in local languages, reported to have reached millions of farmers (Khatri et al., 2024; Byamukama et al., 2025).

FPO-mediated digital extension, India. Rather than requiring farmers themselves to use an app, the head of a Farmer Producer Organization operates the digital platform on the farmers' behalf, entering farm-specific data and relaying personalized advice on crop selection, inputs, and scheduling through phone calls and text messages (Rajkhowa & Qaim, 2021).

Digital Green. A video-based approach to farmer training and knowledge sharing, used to improve access to best practices (Khatri et al., 2024; Byamukama et al., 2025).

Beef Brunch, USA (Louisiana). A series of monthly live webinars and bi-weekly updates for cattle producers, with 85% of viewers reported to have applied what they learned (Beck et al., 2021).

Taken together, these examples show that "virtual extension" isn't one technology it's a spectrum, from a fully automated hotline to a trained human relaying advice by phone.

Virtual Extension Does Not Have to Mean "No Human"

Of all these models, the FPO-mediated example from India is perhaps the most instructive, precisely because it complicates the assumption that going digital means cutting people out. In this model, digital illiteracy would normally prevent farmers from using an internet-based application directly. So instead, the FPO head becomes a human intermediary, operating the platform on members' behalf and relaying personalized advice back to them (Rajkhowa & Qaim, 2021). That points to a useful principle: sometimes the smartest virtual extension system is not the one that removes the human, it is the one that puts technology in the hands of a trusted human intermediary. The technology extends what one knowledgeable, trusted person can do for their community; it doesn't have to replace them.

Can Virtual Extension Actually Improve Farm Performance?

In India, personalized digital extension services were found to be positively and significantly associated with input intensity, production diversity, crop productivity, and crop income among smallholder farmers (Rajkhowa & Qaim, 2021). Zooming out, a broader meta-analysis of 20 studies mostly from Sub-Saharan Africa and India found that digital information interventions increased fertilizer adoption by 23%, yields by 6%, and income by 6%; notably, the effect on improved seed adoption was not statistically significant (Beach et al., 2025). A separate global scoping review found that most digital advisory studies report outcomes tied to practice change and increased farmer knowledge, but that solid data on environmental sustainability and climate resilience outcomes remains lacking (Porciello et al., 2022). None of this should be read as a guarantee. Considerable variability exists across individual studies, and the evidence base is currently insufficient to reliably separate out how much of the impact comes from the type of intervention, the level of human assistance involved, or the specific delivery method used (Beach et al., 2025). These are real, measured effects from real studies not a promise of what will happen with every digital platform, in every setting, for every farmer.

The Virtual Extension Agent Must Feel Human

Here's a detail that might be surprising: even when a "virtual agent" is software rather than a person, how human it feels still matters enormously to whether people trust and use it.

Researchers describe this as perceived humanness signaled through things like agency, emotion, and a sense of moral awareness and it has been found to be positively associated with customer satisfaction in service encounters (Söderlund & Oikarinen, 2021). More specifically, three particular behaviors in virtual agents engaging in personal conversation, listening, and displaying warmth have been shown to boost users' perceptions of how much effort the agent is putting in, which in turn increases satisfaction (Söderlund et al., 2022). Why would this matter in a farm advisory context? Because farmers reaching out about a struggling crop or an unfamiliar pest usually aren't just looking for a data point. They're often looking for explanation, reassurance, context, and some sense that whoever or whatever is on the other end actually understands the specific problem they're facing.

Text, Voice or Avatar: How Should a Virtual Agent Communicate?

There isn't one right answer here, and the evidence doesn't support treating any single format as universally superior. Text-based systems can be genuinely useful they're often the lowest-bandwidth, most widely accessible option. Voice-based interaction can improve accessibility for users who read less comfortably or prefer speaking. And in some contexts, embodied virtual agents that combine a visual presence with voice output have been found to generate greater user trust than text-only or voice-only approaches, with trust increasing along something close to a straight line from no agent at all to a fully embodied interaction (Weitz et al., 2020). What seems to matter most is the underlying interaction style: end-users generally want to be able to ask questions and receive understandable explanations suited to intuitive comparisons, rather than raw technical output (Weitz et al., 2020). The right format for any given farmer will likely depend on their literacy, language, connectivity, digital comfort, age, and the type of problem they're trying to solve which is exactly why a mix of channels tends to serve farming communities better than a single one-size-fits-all app.

COVID-19: The Moment Extension Went Virtual

If there was ever a moment that proved virtual extension could shift from optional experiment to essential infrastructure almost overnight, it was the pandemic. At Kansas State Research and Extension, agents shifted from texting as their primary internal communication channel toward a mix of Zoom, texting, and Microsoft Teams and notably, the intensity of virtual communication kept increasing even after agents returned to their offices (Messerla et al., 2023). At Louisiana State University's AgCenter, agents built the Beef Brunch Educational Series described earlier combining live webinars with recorded content distributed through YouTube and podcast platforms, which sustained both farmer engagement and the professional development of the extension agents themselves (Beck et al., 2021). The lesson researchers draw from this isn't just that the pandemic forced a temporary shift, it's a forward-looking recommendation. Extension organizations are encouraged to keep offering virtual communication training for new hires who never experienced the pandemic as working professionals, and to keep monitoring how platform use continues to evolve (Messerla et al., 2023).

The Digital Divide: The Biggest Threat to Virtual Extension

For all its promise, virtual extension runs directly into the same wall as every other piece of digital agriculture: a pronounced digital divide. Limited smartphone access, patchy internet connectivity, and unreliable electricity in rural areas restrict the reach of virtual extension innovations, particularly in developing countries (Khatri et al., 2024; Byamukama et al., 2025). This creates an uncomfortable paradox worth sitting with: the farmers who may stand to benefit most from digital extension those in the most remote or under-served areas, furthest from a field agent's regular route may also be the farmers least able to access it in the first place.

Extension Professionals Also Need Digital Skills

It's tempting to think of the digital divide as a farmer-side problem alone. It isn't. Only 30% of extension officers have received formal ICT training, which directly undermines their

ability to facilitate technology adoption among the farmers they serve (Khatri et al., 2024). That statistic matters more than it might first appear. A virtual extension system cannot succeed if the extension professionals meant to run or support it don't know how to use the platforms, can't manage digital communication smoothly, haven't been trained, or struggle to interpret and communicate digital information effectively. Digital extension, in short, requires digitally capable extension professionals the technology alone isn't the whole solution.

When Virtual Extension Fails

Virtual extension systems don't fail for one single reason they tend to fail from an accumulation of smaller, practical problems. Interactive digital extension services face barriers including a lack of two-way interaction, the absence of centralized information networks, poor internet connectivity, and ineffective ICT training (Sen et al., 2025). In Iraq, extension agents specifically identified administrative, financial, technical, and human problems as direct impediments to delivering digital extension, rating the severity of these problems at 2.41 and 2.32 respectively on a 3-point scale (Khalaf & Al-Mashhadani, 2024). And gender and socioeconomic disparities compound the exclusion, with women and marginalized groups often left out of ICT-enabled benefits altogether (Khatri et al., 2024; Byamukama et al., 2025). The underlying point is a simple one: simply building an app does not automatically create an effective extension system. Connectivity, training, two-way communication, and inclusion all have to be designed in from the start.

The Future: Human + Digital Extension

Put the evidence together, and a picture emerges that isn't about choosing between people and technology, it's about combining them. A responsive future extension system is likely to draw on a human extension professional, a virtual platform, the farmer's own input, local knowledge, and digital data, working together rather than any one element working alone. In practice, that could mean blending face-to-face visits, phone calls, SMS, video, AI-assisted advisory tools, online training sessions, and farmer group meetings not as competing options, but as complementary channels. Different farmers, with different needs, connectivity, and comfort levels, are likely to need different combinations of these channels rather than a single standardized system imposed on everyone.

What Should a Good Virtual Extension Agent Look Like?

- **Accessible**: Reachable through channels farmers can actually use, given their connectivity and devices.
- **Understandable**: Communicating in plain, local-language terms rather than technical jargon.
- **Responsive**: Answering quickly enough to matter for time-sensitive farming decisions.
- **Localized**: Grounded in the crops, conditions, and language of the farmer asking.
- **Interactive**: Allowing farmers to ask follow-up questions rather than receiving one-way broadcasts.
- **Trustworthy**: Consistent, credible, and transparent about where advice comes from.
- **Human-centered**: Designed around what farmers actually need, not just what technology can do.
- **Affordable**: Usable without imposing costs that put it out of reach for the farmers who need it most.
- **Inclusive**: Deliberately built to reach women, smallholders, and marginalized groups, not just the most digitally confident users.

Virtual Extension Should Not Replace the Human Extension Professional

It's worth being direct about this: nothing in the evidence supports the idea that virtual extension will make human extension professionals unnecessary. Human extension remains essential for complex farm problems that don't fit a standard advisory script, for building trust

over time, for incorporating local knowledge that no database fully captures, for the social interaction that supports real behaviour change, for hands-on demonstrations, for mobilizing communities around shared goals, and for reaching farmers in situations where digital access simply isn't there yet. The future of extension is unlikely to be human versus machine. It is more likely to be human plus machine.

How to Build a Better Virtual Extension System

- **For extension organizations:** train extension officers in ICT, build genuine two-way communication into digital platforms, combine digital tools with continued face-to-face extension, monitor how platforms are actually being used, and keep training programmes current as technology evolves.
- **For technology developers:** design farmer-friendly interfaces, support local languages, enable both voice and text interaction, build systems that remain usable under limited connectivity, and build trust and transparency directly into how virtual agents communicate.
- **For policymakers:** improve rural connectivity, expand electricity access, work to reduce digital inequality, support digital literacy programmes, and invest in the broader infrastructure extension services depend on.
- **For extension professionals themselves:** develop digital communication skills, use virtual tools to complement rather than replace field visits, maintain the human interaction that builds trust, and use digital platforms deliberately to reach more farmers, not fewer.

Conclusion: The Extension Agent May Go Virtual — But Trust Must Remain Human

Technology can make agricultural extension faster, wider-reaching, more personalized, more flexible, and potentially more cost-effective. The evidence gathered so far from Tanzania's Ushauri hotline to India's personalized SMS advisories to Louisiana's cattle-producer webinars shows real, measurable gains in several contexts. But none of that happens automatically. Successful virtual extension depends on connectivity, digital literacy, proper training, genuine two-way communication, local relevance, and running through all of it human trust. The extension agent of tomorrow may not always knock on a farmer's door. Sometimes, the extension agent may arrive as a message, a voice, a video, or an intelligent digital assistant. But behind successful agricultural extension, one thing will remain essential: trust.

References

1. Beach, R. H., Milliken, C., Franzen, K., & Lapidus, D. (2025). Meta-analysis of the impacts of digital information interventions on agricultural development. *Global Food Security, 45*. https://doi.org/10.1016/j.gfs.2025.100866
2. Beck, P. A., Robe, J., Lalman, D., Zook, D., New, M., Ward, E., & Freking, B. (2021). Integration of Virtual Programming into Beef Cattle Producer and Extension Agent Education. *Journal of Animal Science, 99*, 6–7. https://doi.org/10.1093/jas/skab096.008
3. Byamukama, W., Ssemakula, E., Ssekandi, J., Shaman, A., Businge, P., Kalibwani, R., Atukunda, C., & Turyasingura, B. (2025). A Review of ICT Integration in Agricultural Extension Services. A Global Perspective. *East African Journal of Interdisciplinary Studies.* https://doi.org/10.37284/eajis.8.1.3023
4. Khalaf, A. G., & Al-Mashhadani, A. L. J. (2024). Problems of Using Digital Agricultural Extension in Providing Agricultural Extension Services from the Viewpoint of Agricultural Extension Agents. *Iraqi Journal of Market Research and Consumer Protection.* https://doi.org/10.28936/jmracpc16.2.2024.(8)
5. Khatri, A., Lallawmkimi, M. C., Rana, P., Panigrahi, C., Minj, A., Koushal, S., & Ali, M. (2024). Integration of ICT in Agricultural Extension Services: A Review. *Journal of Experimental Agriculture International.* https://doi.org/10.9734/jeai/2024/v46i123146

6. Klerkx, L. (2021). Digital and virtual spaces as sites of extension and advisory services research: social media, gaming, and digitally integrated and augmented advice. *The Journal of Agricultural Education and Extension, 27*, 277–286. https://doi.org/10.1080/1389224x.2021.1934998
7. Messerla, K. E., Starzec, K. J., Disberger, B., & Johannes, E. (2023). Changes in the information uses and gratifications of virtual communications for Kansas State Research and Extension agents during the COVID-19 pandemic. *Journal of Applied Communications.* https://doi.org/10.4148/1051-0834.2511
8. Naika, M. B. N., Kudari, M., Devi, M. S., Sadhu, D. S., & Sunagar, S. (2021). Digital extension service. 285–323. https://doi.org/10.1016/b978-0-12-821470-1.00006-9
9. Ortiz-Crespo, B., Steinke, J., Quiros, C., Van De Gevel, J., Daudi, H., Mgimiloko, M. G., & Van Etten, J. (2020). User-centred design of a digital advisory service: enhancing public agricultural extension for sustainable intensification in Tanzania. *International Journal of Agricultural Sustainability, 19*, 566–582. https://doi.org/10.1080/14735903.2020.1720474
10. Porciello, J., Coggins, S., Mabaya, E., & Otunba-Payne, G. (2022). Digital agriculture services in low- and middle-income countries: A systematic scoping review. *Global Food Security.* https://doi.org/10.1016/j.gfs.2022.100640
11. Rajkhowa, P., & Qaim, M. (2021). Personalized digital extension services and agricultural performance: Evidence from smallholder farmers in India. *PLoS ONE, 16.* https://doi.org/10.1371/journal.pone.0259319
12. Sen, L., Phuong, L. T. H., Chou, P., Dacuyan, F. B., Nyberg, Y., & Wetterlind, J. (2025). The Opportunities and Barriers in Developing Interactive Digital Extension Services for Smallholder Farmers as a Pathway to Sustainable Agriculture: A Systematic Review. *Sustainability.* https://doi.org/10.3390/su17073007
13. Söderlund, M., & Oikarinen, E. (2021). Service encounters with virtual agents: an examination of perceived humanness as a source of customer satisfaction. *European Journal of Marketing.* https://doi.org/10.1108/ejm-09-2019-0748
14. Söderlund, M., Oikarinen, E., & Tan, T. M. (2022). The hard-working virtual agent in the service encounter boosts customer satisfaction. *The International Review of Retail, Distribution and Consumer Research, 32*, 388–404. https://doi.org/10.1080/09593969.2022.2042715
15. Weitz, K., Schiller, D., Schlagowski, R., Huber, T., & André, E. (2020). "Let me explain!": exploring the potential of virtual agents in explainable AI interaction design. *Journal on Multimodal User Interfaces, 15*, 87–98. https://doi.org/10.1007/s12193-020-00332-0