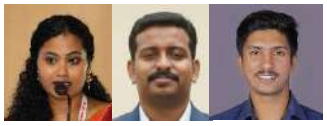
aesa Sharing, learning and networking for innovation **Blog: 276 (June 2026)** Agricultural Extension in South Asia

From Field Visits to Algorithms: How AI can Strengthen Extension and Advisory Services



Artificial Intelligence (AI) is rapidly reshaping agricultural advisory systems by enabling faster, more personalised, and more scalable support for farmers. Aswathy, Pratheesh, and Blesson explore how AI can strengthen extension services, the opportunities it offers, *and the critical role extension agents play in AI-enabled advisory services.*

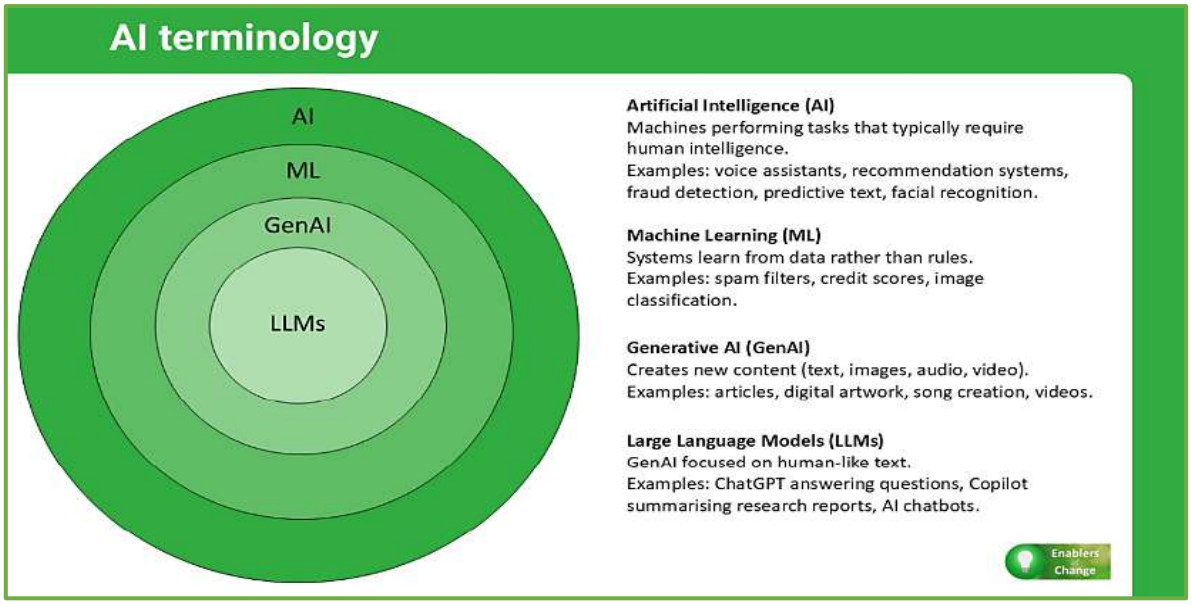
CONTEXT

AI is a powerful tool and a catalyst, providing opportunities for scale and personalisation, but it carries inherent risks around equity, data quality, and trust. AI has strong potential to reach the unreached, especially the smallholders who constitute a major segment of the agricultural workforce; however, this optimism is tempered by limited empirical evidence. With its endless possibilities and rapidly evolving use cases, this blog explores how AI can be meaningfully used to deliver advisory services. It articulates the key challenges and limitations that persist despite the often-optimistic narrative surrounding its potential.

Use of AI in extension and advisory services (AI-generated)

WHAT DOES AI IN FARM ADVISORY MEAN?

AI, machine learning, generative AI, and large language models (LLMs) are often used interchangeably; however, they represent distinct yet interconnected concepts (see the figure given below).



Artificial Intelligence (AI) in farm advisory refers to the use of data-driven digital technologies to deliver timely, accurate, and context-specific information to farmers. At its simplest, AI enables systems to "learn" from large volumes of data, such as weather patterns, soil conditions, crop performance, and farmer queries and translate that learning into actionable recommendations.

Unlike traditional advisory approaches, which are often generalised and supply-driven, AI-enabled systems are demand-driven and adaptive. A farmer can ask a question, upload an image, or receive location- and crop-stage-tailored alerts. This marks a shift from static information dissemination to dynamic, interactive problem-solving.

HOW IS AI REACHING FARMERS ACROSS INDIA?

Emerging AI-enabled advisory initiatives in India demonstrate the growing potential of artificial intelligence to strengthen agricultural extension through multilingual, accessible, and scalable support systems. Platforms such as Farmer.Chat, Bharat-VISTAAR, Sukharakshak AI, and Krushi Samruddhi Helpline are increasingly integrating conversational and generative AI, as well as voice-based interfaces, to provide farmers with real-time guidance on crop management, weather, markets, and climate risks. A notable trend across these initiatives is a focus on inclusivity through local-language support, mobile access, and voice-enabled services, making digital advisory more accessible to smallholders. While some platforms are still in pilot and early-scaling stages, their expanding reach highlights the growing shift from conventional information dissemination to interactive, data-driven, and farmer-centric advisory ecosystems in Indian agriculture. As AI-powered advisory tools increasingly enter the advisory landscape, understanding how farmers perceive and interact with these technologies becomes critical. AI advisory platforms gain farmer acceptance when they feel less like machines and more like trusted advisors. Local-language chatbots, instant accessibility, and interactive conversations make learning easier and more engaging for farmers. At the same time, issues related to unreliable recommendations, data security, and trust remain major barriers to large-scale adoption.

WILL AI REPLACE EXTENSION AGENTS?

The rapid rise of Artificial Intelligence (AI) in agriculture has sparked a familiar concern- Will AI replace extension agents? This question often emerges in discussions around digital advisory tools, especially as chatbots, predictive systems, and automated platforms become more capable. However, framing this as a replacement debate oversimplifies a much more nuanced reality.

At first glance, AI systems appear to replicate many functions traditionally performed by extension personnel, such as answering queries, diagnosing problems, and providing recommendations. Tools such as Farmer. Chat can respond instantly to thousands of farmers, something no human system can match in scale.

However, agricultural advisory is not merely about information delivery. It involves interpretation, contextualization, trust-building, and behavioural change, areas where human extension agents remain indispensable. Farmers often operate in complex socio-economic and ecological contexts. A technically sound recommendation may not be practically feasible due to labour constraints, financial limitations, or local cultural practices. Extension agents play a critical role in translating generic recommendations into locally relevant solutions, something AI systems are still limited in achieving independently.

Studies on AI-enabled advisory, including chatbot-based interventions, consistently highlight the importance of human-mediated systems. While farmers appreciate the speed and accessibility of AI tools, their trust in the information often increases when it is validated or reinforced by a human expert. There are several reasons for this:

- **Contextual Understanding:** Extension agents understand local agro-ecological conditions, cropping systems, and farmer realities in ways that AI may not fully capture.
- **Trust and Credibility:** Long-standing relationships between farmers and extension personnel foster trust, which is critical for the adoption of new practices.
- **Handling Complexity:** Complex or ambiguous problems often require judgment, experience, and negotiation, all of which are essential to human expertise.
- **Capacity Building:** Extension agents do more than advice; they train, demonstrate, and build long-term capabilities among farmers.

In this sense, AI can handle routine, repetitive, and data-intensive tasks, while extension agents focus on high-value, context-specific, and relational aspects of advisory.

BEYOND THE MYTH: WHY AI NEEDS EXTENSION AGENTS MORE THAN EVER

The integration of AI into agricultural advisory is not diminishing the role of extension agents. It is, in fact, redefining their significance. Their role is evolving from disseminators of information to orchestrators of knowledge, trust, and technology.

Extension professionals are now positioned to

1. **Act as Knowledge Curators**: Ensuring that AI systems are trained on accurate, locally relevant, and up-to-date information.
2. **Validate and Interpret AI Outputs**: Translating AI-generated advisories into actionable insights tailored to farmer conditions.
3. **Bridge the Trust Gap**: Serving as intermediaries who build farmer confidence in digital tools.
4. **Facilitate Digital Inclusion**: Helping farmers navigate and effectively use AI-enabled platforms.
5. **Provide Feedback Loops**: Continuously improving AI systems by feeding field-level insights back into the technology.

CHALLENGES AHEAD

Lack of Quality Data to Train AI

Although substantial agricultural data are being generated by research institutions, digital platforms, remote sensing, IoT devices, and government databases, significant gaps remain in data quality,

standardisation, interoperability, and real-time availability. In many cases, datasets are fragmented, outdated, regionally biased, or insufficiently validated. Moreover, much of the tacit knowledge held by extension personnel and experienced farmer's remains undocumented and therefore unavailable for training the models.

The challenge becomes even more critical when AI is expected to deliver highly localised and actionable advisories. An inaccurate recommendation on pest management, irrigation, or fertiliser application can directly affect farmers' livelihoods, making reliability and contextual relevance essential. Therefore, the future effectiveness of AI-driven advisory systems will depend not merely on the sophistication of algorithms but also on the availability of robust, inclusive, and continuously updated agricultural datasets.

Digital Divide

The findings of the National Family Health Survey 2019-21 indicate that only about half of the rural adult population has a smartphone with internet access, and the situation is even worse among rural women and socially marginalised communities. Further, nearly half of rural adults do not effectively use the internet for informational purposes, highlighting significant levels of digital illiteracy. The challenge is particularly important in agriculture, where more than 86% of farmers in India are small and marginal holders. Despite rapid advancements in digital agriculture initiatives, expert assessments suggest that fewer than 20% of Indian farmers actively use digital technologies in farming. Limited affordability of smartphones and internet services, low awareness, language barriers, and lack of trust in digital platforms continue to restrict adoption.

High Cost of Infrastructure and Maintenance

Developing and maintaining AI systems requires investments in cloud infrastructure, sensors, data management systems, satellite integration, and continuous model training, which may not always be economically sustainable.

Data Privacy and Ownership Concerns

Questions regarding who owns farmer data, how data are collected and used, and whether farmers provide informed consent remain largely unresolved. For example, farmer data may be shared with private companies without clear consent, AI systems may promote biased recommendations favouring specific products or firms, and inaccurate advisories on pesticide use or crop management may adversely affect farmer livelihoods. There are also concerns that smallholders and digitally disadvantaged groups could be excluded from AI systems trained on limited or biased datasets. These issues highlight the need for clear policies on data ownership, consent, and responsible use of AI in agriculture.

Policy and Regulatory Gaps

While conventional extension systems also face challenges related to accountability and advisory quality, AI-enabled systems introduce new governance concerns because recommendations may be generated through opaque algorithms, private digital platforms, and automated processes operating at large scale. Questions regarding liability for incorrect advisories, ethical use of farmer data, and standardisation of AI systems, therefore, require clearer regulatory frameworks.

CONCLUSION

The future of agricultural advisory is not a contest between humans and machines, but a collaboration between the two. While AI can process data, generate recommendations, and expand outreach at unprecedented scale, extension professionals remain central in interpreting complexity, building trust, and translating knowledge into meaningful action. There is a growing need to equip future extension professionals with the skills to use AI-enabled tools and platforms effectively. Extension personnel of the future will not only disseminate information but also interpret AI-generated advisories, validate recommendations using field realities, and help farmers navigate digital technologies responsibly. It therefore becomes essential to build capacities of extension professionals in areas such as digital literacy, data interpretation, AI-assisted decision-making, and ethical use of technology to ensure that AI-supported advisory systems remain trustworthy, inclusive, and context-specific rather than purely technology-driven.

A hybrid model for better delivery of EAS (AI-generated)

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