

Digital Divide in Agricultural Extension: Challenges in Reaching Small and Marginal Farmers

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INTRODUCTION

Digital technologies are transforming the delivery of agricultural information to farmers. Now, mobile phones, agricultural applications, social media, AI, video advisories and digital platforms allow information on weather, pests, markets, inputs and crop management to be delivered in seconds. But the rewards of this disruption are not equally shared. Small and marginal farmers are also confronted with challenges of access to the internet, affordability, digital literacy, language, access to devices, and reliability in using technology. So, the real challenge in digital agricultural extension is not simply to scale technology, but to ensure that technology can be made available, accessible, comprehensible to and usable for every farmer.

A Message Sent is not Always a Farmer Reached

Consider a small vegetable farmer who receives a warning about heavy rain after the crop has already been watered. Or a woman looking after the family farm who cannot hear an irrigation advisory because the family phone is with someone working outside the village. These scenarios highlight a key challenge of digital agricultural extension: information delivery does not always guarantee that the information will reach the right person at the right time. Mobile apps, videos and automated calls can link research to farming practices, but they are only useful if farmers can access, interpret, trust and apply them.

Understanding the Digital Divide

The digital divide is frequently defined as the gap between those who have access to the Internet and those who do not. In agriculture, however, it is more layered. One farmer may not have a device that works, another may be confused by an app, and a third may know the advice but not have the means to follow through on it. These are gaps in access and coverage, as well as opportunities for gain.

And for small and marginal farmers, just the first gap at that means leaving the others alone. Extension programmes therefore need to follow the entire journey from receiving an advisory to making a useful farming decision.

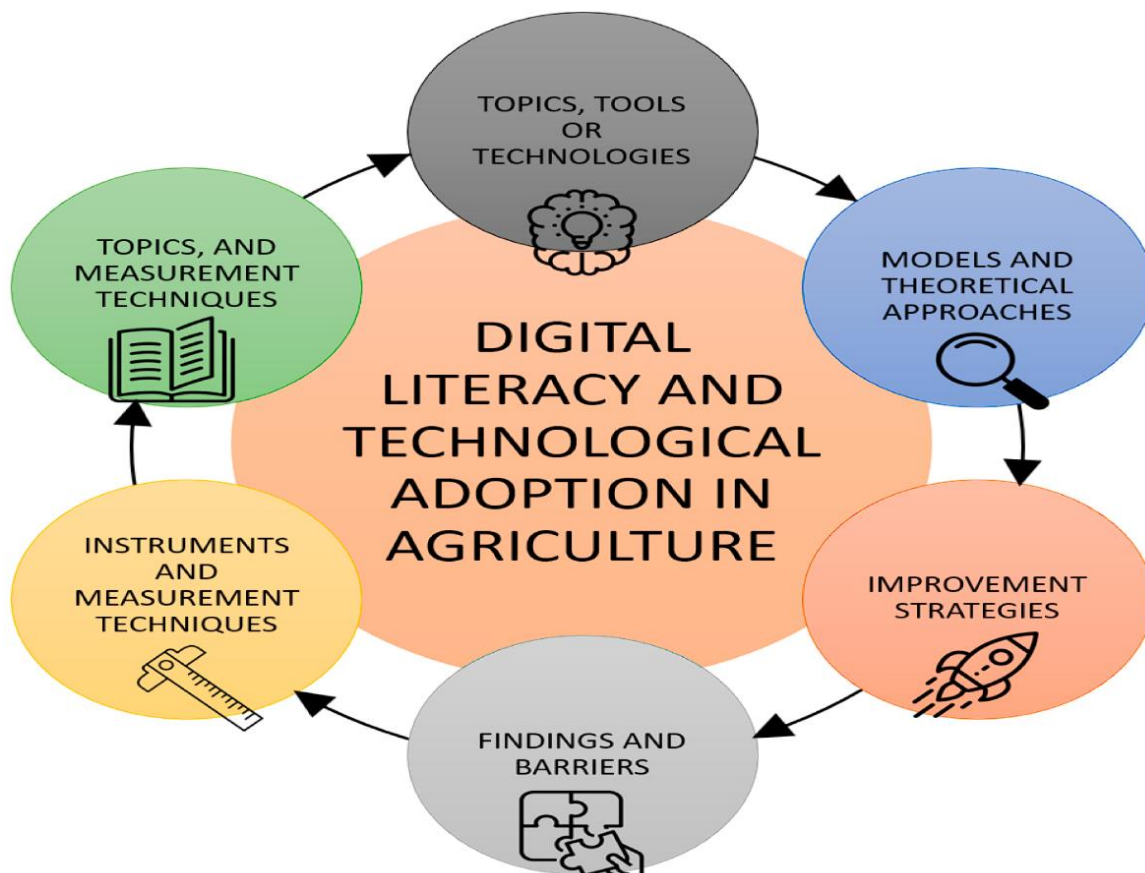
Connectivity and Affordability Shape Access

Reliable access is more than a network signal on a village map. Farmers need signals that function in their fields, power to charge their devices, and sufficient funds to keep them. Buying smartphones, recharging data and fixing devices compete with the costs of cultivation and family needs. So even where internet coverage is available, a service may continue to be unfeasible. Extension programmes should provide for light applications, downloadable audio, and alternatives that use minimal amounts of data. Common infrastructure and basic, affordable essential advisories can broaden participation.

The planning should take into account that farmers can regularly accomplish useful work in the field without incurring costs that exceed the anticipated returns.

Digital Literacy Requires Practical Learning

Knowing how to pick up a phone doesn't necessarily mean knowing how to search for good advice on crops. Farmers may require assistance in choosing their crop, in making a voice query, in finding a trusted source or in regaining access after switching phones. A study conducted in 2025 with 280 women farmers in Kerala reported lack of training as the highest ranked barrier, followed by cost of internet and the issue of poor local mentorship. The result advocates hands-on training in daily farming operations. Multiple demos and a little help: that will help make learning more effective than a single orientation that pretends everyone learns at the same pace.



Reaching Women and Unregistered Cultivators

Digital services may disregard farmers without access to phones or visibility in formal documents. Women running farms may use the device of another member of the household, while tenants and sharecroppers may work on land registered to another individual. Advisory sign up should reflect genuine farming obligations and don't introduce unnecessary ownership criteria. Women's organizations, facilitated registration and user-friendly training timetables can engage such users. Allow programmes to permit easy updates of contact details and change in cultivation arrangements. Tracking individual participation would expose the none of exclusion disguised by household registration statistics, and enable services to find those making day to day farm decisions.

Language and Design can Open Doors

Advisory becomes effective only when its meaning is clear. Formal language, unfamiliar abbreviations and confusing menus can intimidate farmers with excellent hands-on experience but little experience following written instructions. Translations need to convey local meanings, crop names and expressions, not just directly replace words. Audio messages, clear pictures and short videos are also another way to learn. Easy design should also take older users and people with impaired vision or hearing into account. Large controls, customizable playback and easy text should be tested with target users to ensure that even simpler interfaces still convey key information correctly and completely.

Advice must Fit the Actual Farm

A recommendation that is suitable for a well-watered commercial farm may not be suitable for a small rainfed holding. Effective extension needs to consider the crop stage, water

availability, soil conditions, labour and the production goal of the farmer. If not, even ostensibly personalized messages will be too general to perform as intended. A 2025 study on the design of the Makara agricultural advisory application was guided by participatory techniques to investigate patterns of adoption behaviour. This strategy provides a practical insight: farmers have to be involved in problem definition to which a service responds. Early user testing with different kinds of users can challenge assumptions that developers and technologists may take for granted.

Trust Takes more than a Forwarded Message

Digital platforms can put verified recommendations next to ads, personal opinions, and false claims. Then farmers have a hard challenge to assess credibility, especially when multiple messaging lines propose different solutions. Extension should designate the agency from which it originated, the date of release and, the local relevance of the information. A commercial sponsorship should be obvious and advice should not surreptitiously favour a product because the platform is funded by the product's vendor. Farmers need a way to query recommendations too. Trust is enhanced when services explain uncertainty, correct mistakes transparently, and are still around after the delivery of advice, especially if field conditions change.

Receiving Advice is Different from Acting

Research from Odisha illustrates the gap between information delivery and implementation. A study of the National Pest Surveillance System in 2025 reported 851 advisories, among which 418 were complied with, corresponding to a compliance of about 49 per cent. The researchers also noted challenges when recommendations included more costly or complex controls. Since sites

were chosen by system utilization, these results should not be treated as national estimates. Yet they do bring to light a real-world practical problem: advice must take account of resource limitations. An alternative safe extension message should be explored and farmers should be linked to other sources of inputs, services, or collective arrangements where feasible.

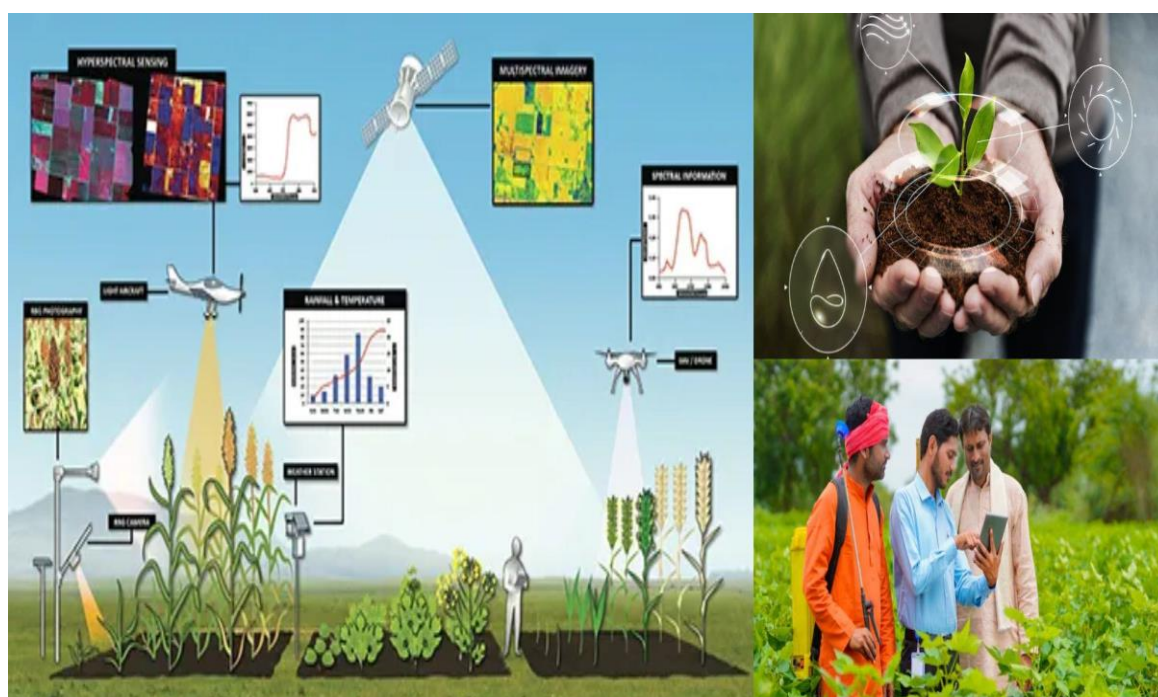
Timely Follow-up Improves Usefulness

Accurate advice may lose its value if it comes late for the operation in question. Farmers also need to be reminded when a single action is spread over multiple stages within a season. A 2026 study of Rice Crop Manager in Odisha showed higher adoption rates for telephone delivery with multiple reminders compared to a single interaction that provided printed advice. This does not mean calls are better for everyone, on account of the differing nature of the follow-up. It does indicate that continuity is important. Advisory calendars should be aligned with crop development and farmers routines and include the possibility of seeking

clarification of the instructions before the time for effective action expires.

Strengthening Human Support Behind Digital Services

Digital extension has to have a clear path to a real person when normal messages are not enough to solve a problem. Farmers may have difficulty understanding symptoms or field conditions or why advice received earlier did not work. Krishi Vigyan Kendras, extension workers and farmers organisation can facilitate this interface in discussions and field visits. But the personnel must be trained, the equipment dependable and they must have adequate time to answer. A level of coordination among platforms and minimization of duplicate reporting would also free up time that could be better spent on providing advisories. The institutions should make an official in charge for the unaddressed queries and incentivize for good problem solving so that digital services reinforce the farmer-extension worker relation continuum.



Protecting Data and Using AI Responsibly

Personalisation may involve data on crops, locations and farming techniques, but services should only gather the minimum necessary information and be transparent about its usage. Farmers need to make informed decisions about information sharing and commercial messages. AI adds another layer of design responsibility: a fluent answer can be factually incorrect or not relevant to a specific field. Systems should be trained on verified agricultural data; be able to communicate their limitations and escalate cases that they are not confident about to trained human experts. Evaluations should incorporate local languages and crops before a broader launch. Accountability needs to be clear so that farmers know who to approach to ask questions or to report a harmful recommendation.

Building Services that Last Beyond a Pilot

A promising resource can become useless when its project support is withdrawn, phone numbers go dead or information becomes outdated. Long-term planning should identify who will provide the maintenance, pay the facilitators, review the content and attend to complaints. Farmer producer organisations, cooperatives and local bodies can play a role in ensuring continuity if they have realistic roles and resources. The public and private partnerships require transparent agreements, which safeguard the independence of the advisory. Programme managers need to consider whether, before scaling-up a service, it can be sustained as affordable and reliable through a number of cropping seasons, including times when levels of participation or of external funding may be diminished.

Measuring Benefits Beyond Registrations

There is limited evidence of successful extension from download counts and messages sent. Evaluation should examine who used the service, whether advice was understood, what changed on the farm and whether the change improved outcomes after costs. Results should be analysed independently for women, smaller holdings, remote communities and other

vulnerable populations. For farmers who stop using a platform, special attention should be paid as their experiences can reveal previously unrecognized barriers. This feedback should inform revisions to content and delivery. In some cases, comparisons between seasons and appropriate evaluation designs can help to isolate programme effects from weather and other factors.

Making Digital Extension Work for Everyone

Bridging the digital divide depends on simultaneous advances in access, learning, service design, and institutional support. As a first practical step, farmers who are left out can be mapped, their communication preferences assessed and the most urgent barriers identified. Programmes can then integrate appropriate digital tools with reliable on-the-ground support and feedback on results with participating communities. Small and marginal farmers should be given a say in the shaping of these services as they evolve. The idea is to develop an extension system such that a worthwhile advice reaches the decision maker, on time, and can be utilized on the farm given the farm conditions.

CONCLUSION

The digital divide in agricultural extension cannot be bridged only by improving the penetration of smartphones or internet connectivity. Quality digital extension needs affordable access, relevant digital literacy, locally relevant content, timely and farm-specific recommendations, reliable information and quality human support. There is also a need to focus on women farmers, tenant farmers and other vulnerable groups who may not appear in traditional registration systems. Digital tools should be a support to extension workers and local institutions, not a replacement. In the end success should be measured not by downloads or messages delivered, but by whether farmers comprehend the advice, follow it and achieve meaningful improvements in their farming and livelihoods.

Making Digital Extension Work for Everyone

Same Knowledge
More People
Better Farms

Inclusive Farmers
Stronger Futures

Digital Knowledge
Brighter Harvests

ACCESS

- Identify excluded farmers
- Use preferred channels
- Voice
- Video
- SMS
- App
- Community radio

LEARNING

- Local assistance

SERVICE DESIGN

- Timely, practical advice
- Local language & local context
- Useful for the farm

INSTITUTIONAL SUPPORT

- Strong extension systems
- Partnerships (NGOs, private sector, research)
- Enable policies & resources
- Community feedback

Right message • Right farmer • Right time • Real farm action

Advice reaches farmer

Farmer understands

Applies on farm

Better crops and livelihoods

Diverse Farmers
Shared Knowledge
Thriving Communities

Digital Extension
for Inclusive
and Resilient
Food Systems