



Digital Extension Services and Farmer Decision Making Under Uncertainty

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Farming involves decisions made with incomplete information about rainfall, pests, input prices, crop performance and market returns. Digital extension services including mobile advisories, voice messages, call centres, apps and online farmer networks can help reduce these information gaps by delivering timely and locally relevant guidance. Evidence from India suggests that personalised digital advice is associated with changes in input use, crop choices, productivity and farm income, although benefits depend on access, trust and the ability to act on recommendations. This article discusses how digital extension can support decisions under uncertainty, while highlighting the importance of credible information, local validation and continued human support.

Keywords: Digital extension, agricultural advisory, farmer decision-making, uncertainty, climate risk, information and communication technology (ICT)

Introduction

A farmer rarely makes a decision with complete certainty. At sowing, the timing and amount of rainfall may be unclear; during crop growth, pest outbreaks can emerge unexpectedly; and at harvest, prices may change before produce reaches the market. These uncertainties can lead to cautious input use, delayed adoption of improved practices or costly decisions based on incomplete information. Agricultural extension traditionally addresses such problems through field demonstrations, training and direct contact with extension workers. Digital channels now offer an additional way to share advice quickly and at scale (Mittal, Mehar, & Hariharan, 2019). Their value is not simply that information arrives faster, useful advice can help farmers compare options, anticipate risks and make decisions suited to their own farms. (Mittal et al., 2019; Rajkhowa & Qaim, 2021).

How digital services help farmers manage uncertainty

Digital extension includes SMS alerts, interactive voice response, mobile applications, farmer helplines, weather updates, market-price information, video demonstrations and personalised crop advisories. These services can provide guidance on sowing windows, nutrient management, pest identification, irrigation, crop choice and post-harvest handling. When recommendations are timely and relevant, farmers can respond before a risk becomes a major loss. A review of digital agriculture services in low and middle-income countries found that many evaluations report improvements in farmer knowledge and changes in practices, though evidence on wider outcomes such as environmental sustainability is less common (Fabregas, Kremer, & Schilbach, 2019; digital agriculture services scoping review, 2022). (Fabregas et al., 2019; FAO, 2023; Digital agriculture services review, 2022).

From information to better decisions

The economic value of an advisory depends on whether it changes a decision for the better. For example, a forecast-based message may encourage a farmer to postpone spraying when rain is expected, while a pest alert may prompt field scouting before applying a pesticide. Information on input requirements can also help avoid unnecessary expenditure. In an Indian study, personalised digital extension was positively associated with input intensity, production diversity, crop productivity and crop income among smallholder farmers (Rajkhowa & Qaim, 2021). Research on the Direct2Farm mobile advisory programme similarly reported that messages influenced the uptake of agricultural practices, but also found that women, older farmers and smallholders were less likely to engage with the service (CABI Direct2Farm study, 2019). These findings suggest that digital tools can support decisions, but their effects are neither automatic nor equal for all farmers. (Fabregas et al., 2019; Rajkhowa & Qaim, 2021; Direct2Farm evaluation, 2019).

Why uncertainty still matters

A digital message cannot remove uncertainty from agriculture. Weather forecasts may be imperfect, pest conditions differ across fields, and market prices can shift quickly. Generic recommendations may not fit a farmer's soil, irrigation access, crop variety or financial capacity. Farmers may also receive conflicting advice from social media, input dealers and informal networks. If a service does not explain the basis or limits of its recommendations, trust can decline. Digital extension should therefore communicate uncertainty honestly; for example, by presenting a probability or range where appropriate, identifying the date and location of a forecast, and advising farmers to verify serious pest or disease problems with a qualified expert. (FAO, 2023; Digital agriculture services review, 2022).

Barriers to access and practical use

Access involves more than network coverage. Farmers need a suitable phone, affordable connectivity, language-appropriate content, digital skills and control over the device. Audio messages, local-language helplines and simple interfaces can help people who find text-heavy applications difficult. The Direct2Farm evaluation highlighted differences in service use by gender, age and farm size, showing why programmes should consider who owns and controls phones and not just who is registered (CABI Direct2Farm study, 2019). Evidence from Odisha's Rice Crop Manager evaluation also indicates that repeated telephone advisories and reminders can support adoption more effectively than a single interaction, while farmers value simple language and field-level assistance (Bharti et al., 2026). (FAO, 2023; Direct2Farm evaluation, 2019; Mobile phone technology adoption review, 2023).

Building a reliable digital–human extension system

Digital services work best when they complement, rather than replace, extension workers, Krishi Vigyan Kendras, farmer groups and local knowledge. Service providers should use credible scientific sources, update advisories regularly and test messages with farmers before scaling them up. Two-way communication is particularly important: farmers should be able to describe a problem, ask follow-up questions and report whether advice worked. Advisory systems should also protect personal data and disclose commercial interests where recommendations involve products or services. Recent work on ICT-based agro-advisory services stresses the importance of trust, accessibility, responsiveness and perceived usefulness in sustaining farmer engagement (Paliwal et al., 2025; Mittal et al., 2019; FAO, 2023; Fabregas et al., 2019).

Conclusion

Digital extension can help farmers make more informed choices in an uncertain production and market environment by improving the speed, reach and personal relevance of agricultural information. Yet a message is useful only when farmers can understand it, trust it and act on it. Unequal phone access, digital literacy gaps, inaccurate or generic advice and weak follow-up can limit the benefits. A farmer-centred approach should combine reliable digital alerts with

local-language communication, feedback mechanisms and support from trained extension personnel. The goal is not to replace farmers' judgement, but to strengthen it with credible evidence so that decisions become better informed and risks can be managed more effectively. (Rajkhowa & Qaim, 2021; FAO, 2023; Beach et al., 2025).

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