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Impact of ICT, Mobile Apps and Social Media in Dissemination of Entomological Information to Farmers

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ABSTRACT

Information and communication technologies (ICTs) — spanning SMS/IVR advisories, mobile pest-identification apps, social media platforms and, increasingly, AI/deep-learning-based decision support — have transformed the reach and immediacy of entomological information delivery to farmers. This review synthesises empirical evidence on their impact, drawing on a randomised-design impact evaluation of an ICT-enabled fall armyworm campaign in Uganda, farmer-perception surveys of WhatsApp and social media use in India, and documentation of large-scale AI-enabled platforms including India's National Pest Surveillance System (NPSS) and the Plantix diagnostic app. The Uganda evidence shows that ICT-channel exposure raised farmers' pest-knowledge scores by 17–20% and management-practice adoption by 53–55%, with multi-channel exposure roughly doubling single-channel gains. In India, WhatsApp-based dissemination achieved high farmer-reported utility (a Relative Behavioural Quotient of up to 85.94%), while AI-based platforms such as NPSS have issued over 10,000 pest advisories across 61 crops since their 2024 launch. Across the literature reviewed, real-time reach and multimedia/visual learning were the most consistently cited benefits, while digital-divide and connectivity constraints and unmoderated misinformation were the most consistently cited challenges. The review situates these findings within diffusion-of-innovation theory and outlines directions for strengthening ICT-mediated entomological extension.

INTRODUCTION

Timely, accurate information on pest identification, monitoring thresholds and management options is a critical determinant of effective crop protection. Conventional face-to-face extension — training and visit systems, farmer field schools — remains constrained by high farmer-to-extension-worker ratios; for instance, only about 19–29% of farm households in western Uganda report contact with an extension worker in a given year. Information and communication technologies (ICTs), ranging from basic SMS and interactive voice response (IVR) to smartphone applications, social media platforms and AI-powered image recognition, have emerged as a means of extending the reach, speed and richness of entomological advisory services well beyond what conventional extension staffing allows.

This review synthesises recent empirical and documentary evidence on the impact of ICT, mobile applications and social media specifically in the dissemination of entomological (pest-related) information to farmers. It draws on a rigorous impact evaluation of a multi-channel ICT extension campaign for fall armyworm in Uganda, farmer-perception studies of WhatsApp and social media use for crop-protection information in India, and documentation of large-scale government and private-sector AI-enabled pest-surveillance platforms. The review is organised around the evolution of ICT channels, a typology of current tools, the empirical evidence of impact, and a synthesis of recurring benefits and challenges.

EVOLUTION OF ICT CHANNELS FOR ENTOMOLOGICAL EXTENSION

ICT-mediated entomological extension has evolved through overlapping generations of technology rather than a strict linear replacement sequence. Early efforts relied on radio broadcasts and printed bulletins

Table 1. Typology of ICT channels for entomological information dissemination.

Channel	Mode of operation	Illustrative examples (entomological use)
SMS / IVR advisories	Push text or voice alerts triggered by pest-monitoring thresholds; two-way query via short codes	Kisan Call Centre; CABI Plantwise SMS plant-health advisories; Hamwe FAW SMS campaign, Uganda
Mobile pest-ID / advisory apps	Farmer captures a photo; deep-learning/ CNN model classifies pest/disease and returns treatment advice	Plantix (>120 million contributed images, 800 symptoms, 60 crop types); NPSS (India, AI/ML, 61 crops); MyIPM (US Extension); Kisan Suvidha (India, plant-protection module)
Social media & messaging platforms	Peer-to-peer group sharing, short video, live Q&A, crowd-sourced pest reports	WhatsApp farmer groups; YouTube pest-management channels; Facebook agri-extension pages
Interactive radio & village video screening	One-to-many broadcast combined with call-in Q&A or facilitated group viewing	Radio Kitara FAW series; Kibanda Boda solar micro-cinema screenings, Uganda
AI/CNN-based decision support systems	Automated image recognition coupled with real-time advisory generation and outbreak mapping	NPSS AI-based probabilistic pest identification (ICAR-NCIPM); Plantix deep-learning diagnostic engine

for pest alerts; these were followed by SMS and IVR-based advisories that allowed two-way, threshold-triggered communication; the proliferation of smartphones then enabled dedicated pest-identification and advisory apps; social media and messaging platforms subsequently added peer-to-peer and multimedia dimensions; and, most recently, AI/deep-learning models have been embedded within mobile platforms to automate pest identification from farmer-submitted images. Figure 1 depicts this evolution, noting that in practice farmers and extension systems typically draw on several of these channels simultaneously rather than abandoning earlier ones

TYPOLOGY OF CURRENT ICT TOOLS

Table 1 summarises the principal categories of ICT channels currently used to disseminate entomological information, together with illustrative examples drawn from both Indian and international deployments.

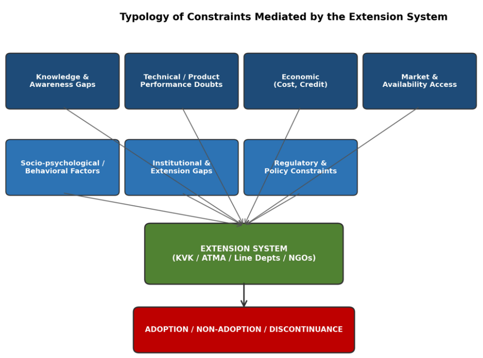

Figure 1. Evolution of ICT channels used for entomological information dissemination, with illustrative examples at each stage.

SMS and IVR Advisories

SMS remains highly accessible because it works on basic handsets, but the literature indicates it is best suited to simple, timely reminders rather than conveying the fuller logic of integrated pest management (IPM); a systematic review found that basic SMS struggled to convey comprehensive IPM guidance, and the Uganda FAW campaign found SMS added little incremental knowledge or practice-adoption benefit once radio and video channels were already in place.

Mobile Pest-Identification and Advisory Apps

Smartphone apps combine image capture with automated or expert-mediated diagnosis. Plantix, a widely used commercial example, draws on a crowd-sourced database exceeding 120 million labelled crop-symptom images to identify roughly 800 symptoms across 60 crop types, and has reported over 1 million diagnostic uses per month. In the United States, the MyIPM series of Extension-maintained apps provides commodity-specific pest, disease and weed management recommendations, including pesticide search and resistance-management tools, explicitly designed to complement rather than replace field demonstrations and in-person Extension outreach. In India, the government-run Kisan Suvidha app bundles plant-protection information alongside weather, market-price and input-dealer modules.

Social Media and Messaging Platforms

WhatsApp has emerged as the dominant social platform for Indian agricultural extension, valued for its low bandwidth requirements, group functionality and support for multimedia (images, voice notes, short videos) alongside text. Studies report high farmer-perceived utility for both general agricultural information and specific crop-protection queries, though several

Table 2. Comparative summary of empirical evidence on ICT, mobile app and social media impact on entomological information dissemination.

Study / source	Channel & location	Key documented finding
Tambo et al. (2019), PLOS ONE	Radio + SMS + video; western Uganda (FAW)	Any ICT-channel exposure raised farmers' FAW knowledge score by ~17–20% and increased adopted management practices by ~53–55% (about 2 extra practices) versus non-participants; multi-channel exposure (radio+video) nearly doubled the knowledge gain of any single channel (28–31% vs. 15–18%); SMS added little incremental effect over radio+video.
Balaji & Kavaskar (2024)	WhatsApp; Cuddalore district, Tamil Nadu, India	68.00% of the 100 sampled farmers reported a high level of perception of WhatsApp as a farm-technology dissemination tool.
Social media study (2023)	WhatsApp/Facebook/YouTube; Himachal Pradesh, India (n=96 farmers, 6 months)	Social media use recorded a Relative Behavioural Quotient (RBQ) of 85.94% for utility in resolving crop/livestock problems; farmers favoured WhatsApp over Facebook; irrelevant posts (RBQ 92.36%) and slow internet (RBQ 61.28%) were the top-cited constraints.
Thirumal & Sekhar Babu (2026)	WhatsApp groups; review synthesis, India	WhatsApp groups improved real-time communication, peer learning and access to localized advisories, but the review flags misinformation spread, message overload, digital divide and absence of moderation as recurring drawbacks.
Government of India / PIB (2025)	NPSS mobile app + portal; pan-India	AI/ML-based National Pest Surveillance System covers pest identification for 61 crops and issues advisories for 15 major crops in 4 languages; 10,154 pest-management advisories issued to date; targeted reach of about 14 crore farmers.
GSMA / Plantix case study	Plantix AI image-recognition app; India, Brazil, North Africa and others	App draws on a crowd-sourced database of over 120 million labelled crop-symptom images to identify 800 symptoms across 60 crop types; reported over 1 million diagnostic uses per month within three years of launch.

reviews caution that the absence of structured moderation allows misinformation and irrelevant content to accumulate in farmer groups.

AI/CNN-based Decision Support

The most recent generation of tools embeds convolutional neural network (CNN) and other deep-learning models directly within mobile and web platforms to automate pest identification from images, in some cases coupled with population forecasting and spatial risk mapping. India's National Pest Surveillance System (NPSS), launched in August 2024 by the Directorate of Plant Protection, Quarantine & Storage in collaboration with ICAR-NCIPM, exemplifies this generation: it applies AI/ML models to identify pests across 61 crops and issues structured advisories for 15 major crops in four languages, drawing on data contributed by state agriculture departments, SAUs and Krishi Vigyan Kendras.

EMPIRICAL EVIDENCE OF IMPACT

Table 2 summarises the key quantitative and documentary findings from the studies and platforms reviewed here.

The most methodologically rigorous evidence reviewed here comes from Tambo et al. (2019), who used propensity-score matching and doubly robust estimators to evaluate a multi-channel ICT extension campaign (interactive radio, SMS, and village video screening) for fall armyworm management in western Uganda. Figure 2 plots the reported gains in farmers' pest-knowledge scores and in the number of management practices adopted, disaggregated by the number of ICT channels a farmer was exposed to.

The additive pattern evident in Figure 2 — where exposure to two channels roughly doubles the knowledge gain of a single channel, while three channels add little further knowledge gain but continue to raise practice adoption — supports the study's central finding that

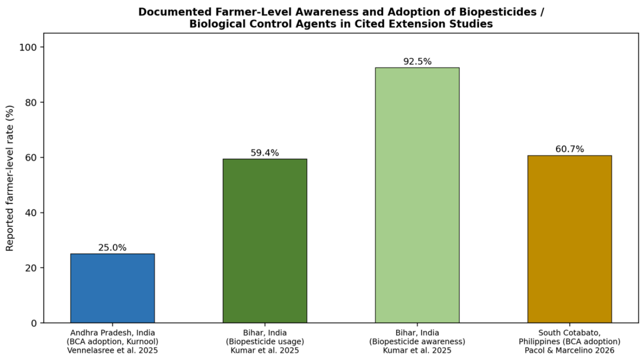

Figure 2. Documented gains in fall armyworm knowledge scores and management-practice adoption by number of ICT channels a farmer was exposed to (Tambo et al., 2019).

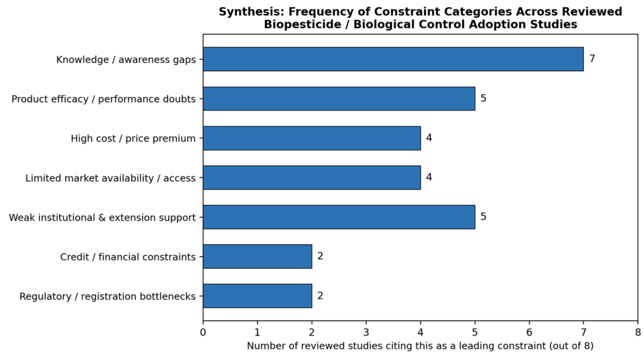

Figure 3. Synthesis of benefits and challenges of ICT/social media dissemination of entomological information, tallied across the eight reviewed sources.

complementary, multi-channel campaigns outperform any single ICT tool used in isolation, and that channels combining verbal and visual communication (radio plus video) are particularly effective for a low-literacy farming population.

DIFFUSION-OF-INNOVATION PERSPECTIVE

Rogers' diffusion-of-innovation framework helps explain differential uptake across the ICT channels reviewed. SMS and IVR advisories score well on trialability and low complexity but poorly on observability and richness of content, consistent with their limited standalone impact in the Uganda evidence. Mobile apps and AI-based diagnostic tools offer higher relative advantage (instant, specific diagnosis) but demand greater compatibility with farmers' existing digital skills and smartphone access, which constrains their reach among older or less digitally literate farmers. Social media platforms, particularly WhatsApp, combine relatively low complexity with strong observability through peer sharing, which plausibly explains their comparatively rapid uptake in the Indian studies reviewed — though this same peer-network structure also facilitates the spread of unverified or inaccurate pest-management advice.

SYNTHESIS OF BENEFITS AND CHALLENGES

Drawing together the benefits and challenges identified across the eight studies and platform documentation reviewed in this paper, Figure 3 presents a qualitative synthesis count of how frequently each theme recurs.Real-time reach and multimedia/visual learning were the most consistently cited benefits, directly reflecting the Uganda finding that video-based channels outperformed text-only or audio-only channels for complex IPM content. On the challenge side, digital-divide and connectivity gaps were the most frequently cited constraint, followed by low digital literacy and the risk of unmoderated misinformation — concerns raised explicitly in reviews of WhatsApp-based extension in India and echoed in the broader ICT-for-extension literature.

RECOMMENDATIONS

• Design multi-channel rather than single-channel campaigns for complex entomological content (e.g., new invasive pests), since the evidence indicates additive gains from combining verbal (radio/voice) and visual (video/image) channels.

• Reserve SMS/IVR for simple, timely trigger alerts (e.g., threshold-crossing notifications) rather than as the primary vehicle for comprehensive IPM education, consistent with its limited standalone impact in the reviewed evidence.

• Invest in moderated, extension-agency-anchored WhatsApp or messaging groups rather than leaving farmer groups entirely informal, to capture peer-learning benefits while limiting misinformation risk.

• Prioritise multilingual, low-bandwidth-friendly design for AI-based diagnostic apps to extend reach beyond digitally literate, well-connected farmers, building on NPSS's multi-language rollout as a model.

• Pair AI-based pest-identification tools with human expert backstopping (call centres, extension agent follow-up) so that automated diagnoses are validated and farmers retain a route to nuanced, context-specific advice.

• Systematically monitor and publish usage and outcome metrics (advisories issued, knowledge/practice change) for government platforms such as NPSS, following the transparent impact-evaluation approach demonstrated in the Uganda FAW campaign.

CONCLUSION

The evidence reviewed here indicates that ICT, mobile apps and social media have measurably improved the reach and effectiveness of entomological information dissemination to farmers, with the most rigorous available impact evaluation showing knowledge gains of 17–20% and management-practice adoption gains of over 50% from ICT-campaign participation, rising further with multi-channel exposure. India's rapid deployment of AI-enabled platforms such as NPSS and widely adopted commercial tools such as Plantix illustrate the scale at which these technologies now operate, while farmer-perception studies confirm strong grassroots demand, particularly for WhatsApp-based peer information sharing. At the same time, digital-divide constraints, digital-literacy gaps and the unmoderated spread of misinformation remain consistent limiting factors across the geographies reviewed. Realising the full potential of ICT-mediated entomological extension will depend less on further proliferation of standalone tools than on the deliberate combination of complementary channels, moderated social platforms, and continued human expert backstopping within a coherent multi-channel extension strategy.

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