

From Call Connection to Farm Performance: Managing Voice-Based Agricultural Extension for Smallholders

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Abstract: Voice-based agricultural extension promises to deliver timely advice to smallholders without requiring literacy, smartphones, or mobile data. Yet service registration and call connection are operational outputs, whereas comprehension, adoption, and farm performance are management outcomes. This structured evidence review examines how interactive voice response, automated voice calls, and bundled voice services convert access into action. Searches of academic indexes, publisher sites, and citation networks through 7 August 2026 yielded 10 core records covering nine programmes or evaluation stages in India, Uganda, Nepal, Tanzania, and Senegal. Five programmes used randomized evaluations, one used a quasi-experimental comparison, and the remainder supplied mixed-method or implementation evidence. Voice services achieved high reach when calls were free, repeatedly promoted, and supported by trusted organizations; nevertheless, short listening duration, menu exit, shared-phone control, and low voluntary call-in frequently reduced effective engagement. Knowledge and practice adoption improved in several settings, particularly when voice was combined with training, video, or reminders, but gains were not consistent across randomized studies. Evidence on yield, cost, and profit was thinner and more variable. To guide service management, the review develops a three-capability framework: voice accessibility, service reachability, and behavioral executability. It recommends managing voice extension as a service funnel, simplifying channel operations, linking call logs with farm outcomes, and measuring cost per effectively engaged farmer and per additional adopter rather than cost per registered user.

Keywords: Interactive Voice Response; Agricultural Extension; Smallholders; Service Operations; Digital Inclusion; Technology Adoption; Farm Performance

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1. Introduction

Digital agricultural extension addresses two persistent management problems: conventional advisory systems are expensive to scale, and information often arrives after a production decision has been made. Mobile delivery can repeat recommendations at planting, fertilizer application, pest outbreaks, or weather shocks while lowering the marginal cost of reaching dispersed farms ^[1]. Across channels, digital advice has produced modest average improvements in recommended input use and agricultural output, although results vary substantially across programmes ^[2]. A broader review of digital agriculture services likewise found that knowledge and practice outcomes are measured more often than income, welfare, and distributional effects ^[3].

Delivery channels impose different operating requirements. Text messages depend on reading ability; smartphone applications depend on devices, data, and interface skills; video requires a screen or organized viewing; and individual calls by extension agents are difficult to scale. Interactive voice response (IVR) and automated outbound calls can operate on basic phones and in local languages. Farmers may listen to recorded advice, navigate a keypad menu, call a hotline, leave a question, or receive a response from a system or an adviser. Voice therefore has a credible channel advantage where text and internet access are weak.

The management challenge begins after a number has been registered. Household phone ownership does not ensure that the intended farmer controls the device. A completed call does not show that the farmer listened to the message, understood it, or considered it relevant. Understanding does not ensure access to seed, fertilizer, cash, labour, or decision authority. Research with developers and users of digital extension in 21 low- and middle-income countries organized these barriers as interface access, content access, and behaviour change ^[4]. Voice services add channel-specific operational issues: phone control, call timing, auditory memory, menu depth, expectations of human assistance, and the ability to reconnect after interruption. Existing reviews usually combine text messages, radio, telephone, applications, and video ^[2-4]. That aggregation is useful for estimating the broad value of digital advice but offers limited guidance for managing a voice channel. Programme studies, in turn, often report local average effects without explaining why one service generates repeated farmer-initiated calls while another free service is used by fewer than one farmer in ten. This review therefore asks three focused questions. First, how reliably do voice services convert registered numbers into meaningful engagement and knowledge? Second, when does engagement proceed to practice adoption and farm performance? Third, which operational design choices shape the conversion process?

The review makes two contributions to business economics and service management. It organizes the evidence as a performance funnel—reach and engagement, knowledge, practice adoption, and farm performance—so that an upstream communication metric is not treated as a substitute for a downstream economic result. It then reframes the digital-extension user journey as three managerial capabilities: voice accessibility, service reachability, and behavioral executability. The evidence shows that voice is a scalable information gateway, while value creation depends on how the service is operated and whether farmers can act on the advice.

2. Review Design

2.1 Review Scope and Service Classification

The review covers smallholders, family farmers, and small-scale crop or livestock producers in low- and middle-income countries. Eligible services delivered production advice on crops, livestock, input use, pest management, or climate adaptation through an automated voice component. Services limited to market prices, finance, insurance, payment information, or non-agricultural content were excluded. Human-only calls, radio, stand-alone text messaging, applications, and text chat were also excluded unless they formed part of an intervention that contained a voice component.

Three service models were distinguished by the farmer's opportunity to interact (Table 1). This classification separates menu-based IVR from one-way voice messages and prevents the effects of a multi-channel package from being attributed automatically to its voice component.

Table 1. Operational classification of voice-based agricultural extension

Service model	Minimum definition	Typical functions	Management use
Model I: Interactive IVR	Farmers select content or submit a request through keypad input, menus, recordings, or callbacks	Inbound hotline, voice forum, topic menu, recorded question and adviser response	Demand-responsive information and issue discovery
Model II: Automated outbound voice	The system initiates a call and plays recorded content, with limited or no farmer navigation	Seasonal reminders, serialized lessons, weather or climate advice	Timely push communication at scale
Model III: Bundled voice service	Voice is delivered with text messages, video, applications, or face-to-face training	Voice reinforcement after video, IVR plus reminders, blended extension	Coordinated multi-channel learning and follow-up

Speech-recognition benchmarks, prototypes without farmer outcomes, studies of extension staff only, and projects that used IVR solely to collect survey data were excluded. Low literacy was treated as an explanatory condition rather than a mandatory inclusion criterion because most studies did not directly measure it.

2.2 Search, Selection, and Extraction

The search covered records available through 7 August 2026. English-language searches combined voice terms (“interactive voice response,” IVR, “voice-based,” “voice message,” “automated voice call,” “voice forum,” and “voice advisory”) with agriculture and extension terms. Sources included Crossref and OpenAlex indexes, AgEcon Search, publisher websites, academic web indexes, reference lists, and forward-citation searches. Project-name searches were conducted for Avaaj Otalo, Digital Green, Direct2Farm, Ushauri, Ama Krushi, and iSAT. Chinese-language title searches combined terms for IVR and agricultural extension. Outcome terms such as yield and income were used only in supplementary searches so that implementation studies reporting engagement or usability would not be missed.

The reporting logic drew on established review-methodology guidance, scoping-review principles, and transparent search reporting^[5-8].

Titles, authors, publication outlets, years, and digital object identifiers were checked before inclusion. When several papers used the same programme and sample, distinct results were retained but the project was not counted twice. For example, the two Avaaj Otalo evaluations using the 1,200-farmer trial were treated as related records^[10,11]. For each study, the review extracted country, production context, sample, comparison group, follow-up period, service model, delivery language, push or pull operation, human support, and outcomes for reach, engagement, knowledge, adoption, yield, cost, profit, and willingness to pay. Evidence was also classified by its decision use: causal or incremental effect, bundled programme effect, or implementation mechanism. Design credibility was assessed through comparison-group quality, treatment exposure, attrition or selection, self-reported outcomes, component separability, and the range over which the result could be applied.

The final evidence base contained 10 core records representing nine programmes or evaluation stages. The purpose of the method was a transparent, decision-oriented synthesis of directly verified voice-extension evidence rather than a pooled effect estimate across heterogeneous interventions.

3. Evidence Landscape and Credibility

3.1 Evidence Portfolio

The studies were conducted in India, Uganda, Nepal, Tanzania, and Senegal and covered cotton, maize, cashew, cereals, fertilizer management, climate services, and pig biosecurity. Five programmes used randomized evaluations, one used propensity-score matching, one used cross-sectional mixed methods, and two were implementation field studies. Table 2 summarizes their operational and outcome contributions.

Table 2. Core studies and their value for management decisions

Programme	Sample and comparison	Voice model	Main result	Decision use
Avaaj Otalo pilot ^[9]	51 initial participants; seven months of logs and interviews	I	Farmers used a voice question-and-answer forum; simple menus could be learned	Menu design and user-demand mechanism
Avaaj Otalo evaluation ^[10,11]	40 villages and 1,200 cotton farmers; voice, voice plus field support, and control; two years	I and II	About 90% of treatment households called in; recommended input use increased; no systematic yield or profit gain	Causal service effect and information-network change
Uganda maize ^[12]	Nearly 4,000 households; video, video plus IVR, video plus IVR and SMS, and control	I and III	IVR produced no stable incremental effect beyond video except for hybrid seed; fewer than 10% called in	Low-use diagnosis and incremental channel value
Uganda pig biosecurity ^[13]	408 households; factorial comparison of face-to-face training and voice learning	II and III	Voice improved selected knowledge outcomes; combined delivery achieved the highest knowledge score	Causal and complementary learning effect

Programme	Sample and comparison	Voice model	Main result	Decision use
Nepal fertilizer management ^[14]	60 cooperatives; endline sample of 886; IVR, radio, app, training, and control	II	Voice did not improve agronomic knowledge or top-dressing adoption; app and training produced positive results	Comparative channel performance
India cashew ^[15]	332 communities and 8,440 registered farmers; video versus video plus IVR and SMS	II and III	The bundle improved knowledge by about 0.22 SD and adoption of at least one practice by 8.2 percentage points; no positive yield effect	Incremental value of a multi-channel package
Ushauri ^[16]	97 farmers; user-centred design and call logs	I	About 58% of calls reached a content endpoint and 42% did not complete navigation	Menu leakage and expectation management
Direct2Farm ^[17]	Six Indian states; service database, survey, and focus groups	III	About 40% of registered users became active; women, older farmers, and smallholders used the service less	Segmentation and inclusion management
iSAT ^[18]	18 villages and 2,720 subscribers; two seasonal surveys with matching	II	Recipients reported lower costs and higher millet and groundnut yield; cowpea yield did not differ	Farm-performance association for climate advice

Study design strength and voice attribution served different managerial questions. The India cashew trial offered a strong estimate of the additional multi-channel package but did not separate IVR from text reminders. Ushauri had no causal comparison yet directly revealed where calls ended and why farmers exited. Effective service management needs both types of information: outcome estimates show whether value was created, and operating data show where value was lost.

3.2 Evidence Strength, Attribution, and Comparability

The evidence portfolio contains three distinct forms of knowledge. Randomized evaluations estimate whether offering a service changes outcomes for an eligible population. Their main advantage is a credible counterfactual, but the estimated intention-to-treat effect may be small when many assigned farmers never use the service. This is not simply a statistical inconvenience. Low take-up is itself a management outcome: it shows that the delivery process did not convert availability into use. The Uganda maize trial is particularly informative in this respect. The free IVR component was technically available, yet voluntary call-in was uncommon, so the result captures the value of offering the channel under realistic use rather than the effect among intensive users alone ^[12]. Incremental multi-channel evaluations answer a different question. The cashew study estimated the additional value of IVR and text follow-up after a common video intervention ^[15]. This comparison is close to a real resource-allocation decision faced by an extension organization: whether follow-up communication is worth adding to an existing programme. It cannot identify the isolated contribution of voice, but it can identify the return to the package that a manager would actually procure and operate. Similarly, the Uganda pig factorial design is valuable because it examines how voice learning interacts with face-to-face training rather than treating digital and human extension as substitutes ^[13].

Implementation and user-centred studies reveal mechanisms that average effects may conceal. Call logs identify message duration, repeat use, navigation paths, and abandonment. Interviews explain why a technically successful call may not satisfy the user. In Ushauri, some farmers left the menu because they expected immediate contact with a person ^[16]. That finding is actionable even without a control group: the service proposition, opening prompt, and escalation route can be redesigned. Avaaj Otalo's early field study likewise showed how a familiar voice forum and a learnable menu could elicit questions from farmers who would not use a text interface ^[9].

Comparability remains a substantive rather than merely methodological issue. "Voice extension" included farmer-initiated forums, outbound lessons, climate advisories, reminders after video, and voice embedded in broader mobile services. Outcomes were measured at different points in the value chain, from a call reaching content to seasonal profit. The synthesis therefore compares conversion problems and management functions before comparing effect size. A high connection rate

and an adoption effect belong to different stages; a package effect and an isolated voice effect answer different investment questions. This separation produces a more useful evidence map than a simple count of positive and null studies.

4. From Call Connection to Farm Performance

4.1 Reach and Effective Engagement

Voice services can reach large farmer populations, but participation varied with service architecture. In the two-year Avaaj Otalo trial, about 90% of treatment households called the service at least once and made approximately 22 calls on average ^[10]. In the India cashew programme, 93.79% of 6,160 farmers assigned to the bundled service connected to at least one voice message ^[15]. Both programmes reduced direct user cost and operated through trusted organizations with continuing promotion.

Connection was not equivalent to exposure. Cashew farmers listened for approximately 31 seconds to messages averaging 47 seconds ^[15]. In Ushauri, about 42% of calls did not pass through the menu to a content endpoint, partly because some callers expected a person to answer immediately ^[16]. In the Uganda maize trial, only a small share of the 2,414 households offered a free IVR number actually called, despite instructions and access to the service ^[12]. The contrast is operationally important: Avaaj Otalo combined outbound prompts, a free hotline, repeated use opportunities, and adviser responses, whereas the Uganda hotline functioned mainly as a supplementary repository after video screening.

A useful voice-service dashboard should therefore move beyond registered users and successful dial attempts. The operational sequence is: valid number, successful connection, intended farmer reached, content endpoint reached, minimum listening dose completed, repeat use, and question submitted or answered. Measuring each stage makes it possible to distinguish a coverage problem from a navigation, relevance, or retention problem.

4.2 Knowledge and Comprehension

Knowledge effects were conditional on programme design. Local-language serialized voice learning improved selected biosecurity knowledge among Ugandan pig farmers and reinforced prior face-to-face training ^[13]. In Nepal, voice messages did not improve specific or general agronomic knowledge, while the smartphone application and in-person training generated positive effects ^[14]. The Uganda maize evaluation similarly found no additional knowledge gain when IVR was added to video ^[12].

The India cashew package increased knowledge by approximately 0.22 standard deviations relative to video alone ^[15]. This result demonstrates the value of follow-up communication and repeated exposure, while the package design leaves the contribution of voice and text reminders combined. Across these studies, local language reduced the literacy requirement, but learning also depended on listening duration, message structure, prior training, and the relationship between the advice and the farmer's immediate decision.

4.3 Practice Adoption

Practice adoption showed a similar pattern. Avaaj Otalo changed farmers' information sources and increased sustained use of recommended cotton inputs ^[10]. A related analysis showed that the service also changed whom farmers approached for agricultural information, indicating that digital advice and peer networks can interact ^[11]. The cashew package increased the probability of adopting at least one recommended practice by about 8.2 percentage points ^[15]. In Uganda, IVR produced a limited incremental effect for hybrid seed but no stable improvement in broader practice indices ^[12]; in Nepal, the voice treatment did not increase fertilizer top-dressing ^[14]. These results position voice as a decision-support channel rather than a self-contained adoption programme. Advice becomes actionable when the requested behaviour is clear, timely, locally relevant, and feasible with available resources. Service managers can improve that conversion by linking messages to input availability, local units of measurement, seasonal calendars, and referral options when the farmer needs credit, supplies, or individualized advice.

4.4 Farm Performance

Farm-performance evidence was less common than engagement, knowledge, and adoption evidence. Avaaj Otalo changed information seeking and selected input use but did not produce systematic gains in yield or profit ^[10]. In Uganda, video treatment improved reported production outcomes, whereas adding IVR did not create an additional production effect ^[12].

The India cashew package improved knowledge and adoption without a positive yield effect during the evaluation period ^[15]. Together, these trials show that a stronger communication result may precede, but does not guarantee, a measurable short-term business result.

The Senegal iSAT study reported a more positive pattern. After propensity-score matching, recipients of local-language climate advice reported approximately 24% lower input and labour costs, 41% higher millet yield, and 21% higher groundnut yield; cowpea yield did not differ significantly ^[18]. The programme illustrates the potential economic value of advice tied closely to weather-sensitive farm decisions. Because service villages were not randomly assigned and farm indicators were self-reported, the estimates are best used as promising operational evidence for future experimental testing.

For managers, the central point is that farm value depends on both adoption quality and the production environment. Weather, output prices, input quality, and complementary farm practices can strengthen or offset the value of one recommendation. Evaluation periods should therefore cover more than one season and include cost, yield, and net-return measures alongside communication metrics.

4.5 Inclusion and User Segmentation

Voice reduces reading and internet requirements but does not remove inequalities in phone control and service use. Direct2Farm recorded lower use among women, older farmers, and smallholders ^[17]. A study in northern Ghana found that conventional phone calls and extension agents were easier for farmers to use independently than IVR ^[19]. Ex-ante research with Rwandan banana farmers identified lower phone access among women ^[20], and women in the India cashew programme had lower connection and listening rates for supplementary messages ^[15]. Ugandan pig farmers nevertheless valued voice learning because it reduced travel and waiting time associated with face-to-face training ^[13].

These findings support active user segmentation. Registration data should distinguish household phone ownership from personal control, and service reports should examine the identity of the actual listener, preferred calling windows, shared-phone arrangements, and the ability to navigate without assistance. Alternative call times, callback options, short menus, and human escalation can make the service more usable without abandoning its scale advantage.

5. Three Capabilities for Converting Voice Access into Farm Value

The evidence refines the established interface-content-behaviour journey ^[4] into three capabilities that can be managed and measured in a voice service.

5.1 Voice Accessibility

Voice accessibility is the ability to receive agricultural content without reading text or using mobile data. It is the direct channel advantage of voice and explains why basic phones and local languages can expand the potential market for advisory services. Voice accessibility is created by more than recording text aloud. Spoken advice must be intelligible at the speed, accent, and audio quality encountered on low-cost phones and weak networks. It must use locally familiar crop names, measures, and action verbs. Audio also places demands on memory: unlike a written message, it is not visible after the call unless replay is offered. Short message units, repetition of the recommended action, and an explicit replay option can therefore be treated as core product features. The service should test comprehension of the spoken instruction, not merely whether users report liking the voice or language.

The channel has particular value where a text interface excludes capable farmers. That advantage should be expressed as an expansion in addressable users and a reduction in the effort required to obtain advice. It should not be assumed from a country's general literacy rate. Individual reading ability, preferred language, hearing, prior phone experience, and the social acceptability of listening to a call all shape actual accessibility. A brief onboarding task can identify which users can operate independently and which users need demonstration or a human-assisted first call.

5.2 Service Reachability

Service reachability is the ability of the intended farmer to control the registered phone, receive or initiate a call at a suitable time, navigate the interaction, and reach relevant content. Number validity, actual listener identity, calling windows, menu depth, interruption recovery, and expectations of human help belong to this capability.

Reachability turns a technically available channel into a usable service encounter. The first operating decision is whether

the system pushes information, waits for a farmer to pull it, or combines both. Push calls reduce search effort and can be synchronized with crop calendars or weather. Pull services preserve farmer choice and reveal demand through selected topics and recorded questions. Their weakness is salience: the farmer must remember the number and perceive a reason to call. A short outbound prompt with a simple callback route can combine the strengths of both modes. The second decision concerns time. A household phone may be carried by a spouse or family member during the working day, and farm labour patterns change across the season. Repeatedly calling at the same unsuitable time can produce a high “attempted reach” figure and little actual exposure. Services can ask users to choose a call window, learn from answered-call patterns, and offer a no-cost callback. When a call is interrupted, the system should resume from the last completed segment rather than restart a long menu.

The third decision concerns trust and expectations. A farmer who expects an adviser but hears a menu may hang up before learning the available options. The opening seconds should identify the organization, state the immediate value of the call, explain whether a person can be reached, and present no more choices than the user can hold in memory. Trust can also be borrowed from cooperatives, extension agencies, producer groups, veterinarians, or local broadcasters. The large participation difference across reviewed programmes indicates that institutional embedding is part of the service design, not background context.

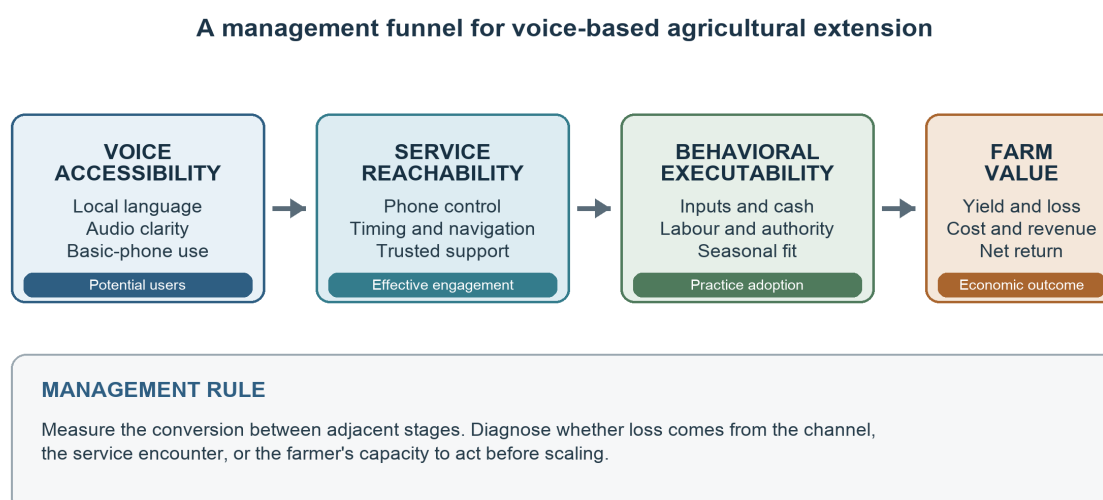
5.3 Behavioral Executability

Behavioral executability is the farmer’s ability to implement understood advice using available cash, seed, fertilizer, labour, land, and household decision authority. Adoption remains an intermediate management result; yield and net return emerge when implementation quality and production conditions also support the recommendation. Executability connects information management with farm economics. A recommendation may be technically correct and well understood yet arrive after inputs have been purchased, require a product unavailable in the local market, or impose labour at a period of peak demand. Managers should therefore assess the “action cost” of each message: money, time, travel, coordination, and risk borne by the farmer. Messages with high action cost may require referral to an input supplier, credit provider, cooperative, veterinary service, or field agent. Messages with low action cost can be delivered as direct prompts and checked quickly through follow-up.

Household authority is equally important. The person listening may not control the plot, budget, or sale decision. Recording the intended decision-maker and, where appropriate, allowing more than one household member to receive the message can reduce this gap. For women farmers using shared phones, flexible call windows and neutral message previews may be more useful than simply increasing the number of female names in a registration database. Inclusion becomes an operating practice when it changes delivery rules.

5.4 An Integrated Value Path

Figure 1. A management funnel linking voice accessibility, service reachability, behavioral executability, and farm value.



The framework prevents performance substitution. Connection rate is not a knowledge measure; knowledge is not an adoption measure; adoption is not a profit measure. Each capability has a corresponding management lever and key performance indicator. Voice accessibility is managed through language, audio clarity, and basic-phone compatibility. Service reachability is managed through timing, navigation, reminders, callback, and human support. Behavioral executability is managed through actionable recommendations, local resource links, and alignment with seasonal and financial constraints.

The three capabilities are complementary rather than additive. Strong audio design creates little value if the intended farmer never controls the phone. High completion creates little value if the advice cannot be implemented. Conversely, a farmer may have the resources to act but receive advice too late. This complementarity helps explain why the same technology produces different results across settings and why adding a digital channel to a successful field programme can be more productive than launching the channel as an isolated substitute. The framework also clarifies ownership inside an organization. Content teams are accountable for voice accessibility; service-operations teams are accountable for reachability; programme managers and partners are accountable for executability and farm outcomes. Shared indicators are still required because local optimization can be misleading. A content team may shorten messages and raise completion while removing necessary detail; an operations team may maximize connections by calling the easiest users and weaken inclusion. The final decision criterion remains additional farmer value relative to total programme cost.

6. Discussion

6.1 What the Evidence Means for Service Management

The findings shift the unit of analysis from the recorded message to the managed service encounter. Value is co-produced: the provider supplies credible content, a functioning channel, and timely support, while the farmer supplies attention, contextual judgement, and implementation resources. A failure at either side can break the conversion process. This explains why technical delivery quality and agronomic accuracy, although necessary, do not by themselves predict programme performance. Voice also changes the allocation of work between automation and extension staff. Automation is efficient for repeated content, reminders, triage, and demand logging. Human support has comparative value in diagnosis, locally unusual cases, and decisions with high downside risk. The managerial task is therefore not to choose between digital and human extension in the abstract, but to assign each task to the channel that handles it at the lowest total cost while maintaining farmer trust and decision quality.

6.2 Channel Portfolio and Operating Design

The results favour a portfolio approach. Outbound calls are suited to time-sensitive reminders because they reduce search effort. Inbound IVR is suited to heterogeneous questions because farmers can request content when a problem arises. Combining the two can create an efficient sequence: a short outbound prompt alerts the farmer, the hotline provides optional depth, and an adviser handles complex or high-risk cases. Automated content then absorbs repeated questions while human staff concentrate on diagnosis and exceptions. Menu architecture should be treated as an operating process. A deep menu raises cognitive and time costs; a shallow menu may offer insufficient specificity. The service can monitor the proportion of calls reaching each node, time to content, repeat listening, abandonment points, and callback requests. Shorter messages, local measurement terms, replay functions, call rescheduling, and interruption recovery are testable improvements. Where users expect a person, the opening message should explain the service immediately and offer a clear path to human assistance.

Multi-channel packages can be valuable when each channel has a distinct role. Video demonstrates a practice, voice reinforces it at the relevant time, text provides a short reminder, and field staff resolve context-specific problems. The cashew and pig-biosecurity studies suggest that reinforcement and channel complementarity can improve learning or adoption ^[13,15]. Management evaluations should preserve this portfolio logic while using factorial or staged designs to identify which component earns its operating cost.

6.3 Performance Measurement and Future Evaluation

Registration volume is an acquisition metric, not a measure of service value. Table 3 converts the framework into a linked management scorecard.

This structure also improves cost accounting. Cost per registered farmer can fall while effective use remains low. More

informative denominators are cost per intended farmer reached, cost per effectively engaged farmer, cost per additional adopter, and cost per unit of net benefit. In Avaaj Otalo, average willingness to pay during the trial was below operating cost per participant, although scale could lower unit cost ^[10]. Resource allocation should therefore consider both conversion and cost: a more expensive service with high completion and adoption may outperform a low-cost broadcast that creates little usable exposure.

Table 3. Management scorecard for a voice-extension service

Value-chain stage	Diagnostic indicators	Primary management question	Typical response
Voice accessibility	Language comprehension; audio clarity; replay rate; independent use	Can the target farmer understand and control the audio interface?	Local-language testing, shorter segments, local measures, replay and onboarding
Service reachability	Valid number; intended listener reached; answer rate; content endpoint; completion; repeat use	Where does the service encounter lose users?	Preferred call windows, callback, shallow menus, interruption recovery, human escalation
Behavioral executability	Correct understanding; input availability; decision authority; timely adoption	Can the farmer implement the recommendation in the current production context?	Action-specific messages, supplier or credit referral, household targeting, seasonal scheduling
Farm value	Yield, avoidable cost, loss reduction, net return, willingness to pay	Does the service create value greater than its full operating cost?	Multi-season measurement, objective farm records, portfolio redesign and targeted scaling

The scorecard is designed for linked analysis rather than four separate reporting systems. Each farmer or anonymized service identifier can connect registration data, call events, short comprehension checks, follow-up adoption, and farm outcomes. Managers can then locate the stage with the largest loss and compare conversion by crop, location, gender, phone-sharing status, or call window. A low overall adoption rate may result from low reach in one segment and low executability in another; the appropriate investment differs. The next generation of evaluations should link call records with independent outcome data. Logs can identify connection, duration, navigation path, replay, and questions, while surveys and farm records measure comprehension, practice, yield, expenditure, and sales. Pre-specified outcomes, field observation, input records, crop cuts, or transaction data would enable managers to connect operating changes to business results. Factorial trials can compare outbound calls, menus, reminders, video, and adviser callbacks under the same content and target population.

The reviewed evidence is concentrated in a small number of South Asian and African programmes, and several economic outcomes are self-reported. The framework should therefore be tested across crops, seasons, and phone-sharing arrangements. This boundary does not weaken the managerial conclusion: voice lowers one important access cost, while service operation and farm-side capacity determine how much value is retained after connection.

6.4 Cost Structure, Business Model, and Governance

Voice services have a distinctive cost structure. Content development, translation, recording, platform configuration, and farmer onboarding are largely fixed or step-fixed costs. Call minutes, message delivery, adviser callbacks, data cleaning, and user support vary with activity. Average cost per registered user therefore falls with scale even when the cost of producing an effective outcome does not. A programme with a large inactive registry can appear efficient under a registration denominator and expensive under an engagement or adoption denominator.

Three financing models are plausible. A public-extension model treats advice as a public or merit good and funds the service through government or development programmes. A cooperative or value-chain model embeds the service in procurement, input supply, quality assurance, or producer support. A user-payment model charges farmers through subscriptions, call fees, or premium advice. The reviewed evidence does not establish one universally superior model. Avaaj Otalo suggests that willingness to pay may not initially cover a feature-rich service ^[10], while the value of climate or animal-health advice may be high when it prevents a costly loss. Pricing should therefore be tested against outcome value, not inferred from call frequency

alone. Governance is especially important when automation and human advice are combined. The organization must define who approves agronomic content, how quickly time-sensitive advice is updated, when a call is escalated, and who is accountable for incorrect or outdated recommendations. Call recordings and behavioural data also require clear consent, access control, retention periods, and rules for sharing with programme partners. These arrangements are part of service quality because farmer trust affects whether the next call is answered.

Procurement decisions should distinguish platform capability from programme capability. A vendor may provide reliable dialing, menu logic, and dashboards, while the extension organization remains responsible for content, farmer segmentation, seasonal scheduling, and referrals. Contracts can include service-level indicators for delivery reliability and data export, but performance payments should not rely solely on calls placed. Including intended-listener reach, content completion, response time for escalated questions, and verified outcome milestones better aligns the operator with farmer value.

6.5 Research Priorities Generated by the Small-Cut Review

The strongest next study is not another broad comparison of “digital extension” with no service. It is a component-level evaluation inside a functioning voice programme. A factorial design could vary outbound prompts, menu access, text reminders, and adviser callbacks while holding content and target population constant. This would estimate whether engagement is generated by the audio message, the reminder, the ability to request information, or the presence of human support. A staged design could then compare the operating cost of each additional conversion.

Research should also randomize delivery features that are currently treated as implementation detail. Examples include short versus long messages, fixed versus user-selected call windows, one-level versus multi-level menus, immediate replay, restart versus resume after interruption, and a recorded answer versus adviser callback. These tests are inexpensive relative to a full agricultural trial and can use platform logs as primary operating outcomes. The most promising features can then be carried into seasonal trials of adoption and farm performance. Exposure measurement requires particular attention. Assignment to a voice service is the correct basis for estimating programme impact, while actual listening is needed to diagnose the mechanism. Future studies should report both. A minimum dataset would include the identity of the intended and actual listener, phone control, answered attempts, listening duration, menu endpoint, repeat exposure, comprehension, and the timing of the farm decision. Linking these fields to objective records—input purchases, field observation, crop cuts, veterinary events, or sales—would reduce dependence on recall and make the management funnel empirically testable.

Finally, distributional value should be evaluated alongside average value. If women, older farmers, or the smallest farms are less likely to control the phone or complete the menu, the service can widen access in aggregate and still concentrate benefit. Trials can test shared-household enrollment, multiple authorized numbers, women-preferred call windows, assisted onboarding, or community listening arrangements. Reporting conversion and cost by user segment will show whether an inclusion feature improves outcomes or only expands registration.

7. Conclusion

Voice-based extension can expand the market for agricultural advice by serving basic phones and local languages, but its economic value depends on the complete service journey. The reviewed evidence identifies the operating conditions that retain value after a call is placed: intelligible audio, control of the receiving phone, suitable timing, low-friction navigation, trusted institutional support, and recommendations that farmers can implement with available resources. Programme managers should therefore design and fund voice extension as a conversion system. The practical priorities are to locate loss with linked stage indicators, use automation for repeated and time-sensitive tasks, preserve human escalation for complex decisions, and evaluate cost against additional adoption and net farm benefit. This service-management approach turns the narrow question of voice delivery into a testable strategy for creating farm value at scale.

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