Harnessing Artificial Intelligence for Agricultural Advisory Services: A Critical Review of Farmer Led Experiences with the 'Ama Krushi' Chatbot in Odisha

Soubhagya Kumar Sahoo [a++*] and Anshuman Jena [a#]

a Department of Agricultural Extension and Communication, Faculty of Agricultural Sciences, Siksha 'O' Anusandhan Deemed to be University, Bhubaneswar, Odisha, India.

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ABSTRACT

Artificial Intelligence (AI) is reshaping agricultural extension by enabling real-time, personalized advisory services. This review critically evaluates the 'Ama Krushi' chatbot, an AI-powered extension platform launched in Odisha under the World Bank-supported SMART Agriculture Project. Leveraging Natural Language Processing, the chatbot delivers localized advisories in Odia and Sambalpuri, reaching over 1.5 million farmers since 2019. AI in agriculture has demonstrated potential to improve decision-making through real-time analytics and personalized

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++ *Ph.D Research Scholar;*
# *Associate Professor;*
Corresponding author: Email: soubhagya2mail@gmail.com;

recommendations. Chatbot platforms enhance access to information in underserved regions. Farmer-led assessments involving 1,200 users indicated that 74% found the service accessible, 68% deemed the content relevant, and 52% reported improved input use and crop planning. Comparative analysis with platforms like mKisan and e-Choupal shows that localized AI tools enhance engagement and relevance. Despite Odisha's 85% rural mobile penetration (TRAI, 2024), barriers persist—especially among women and tribal populations—due to digital divides and limited offline support. The review advocates a systems-level strategy for AI integration, emphasizing co-design, multilingual access, and hybrid (AI + human) models. The Ama Krushi experience offers valuable insights for developing scalable, inclusive, and ethically grounded AI-driven extension services tailored to smallholder needs in the Global South.

1. INTRODUCTION

Through the incorporation of advanced technologies, agriculture—the foundation of rural economies—is undergoing a dramatic transition. Natural language processing (NLP), deep learning (DL), machine learning (ML), and artificial intelligence (AI) have all become increasingly potent instruments in recent years for changing the agricultural landscape. Unpredictable weather patterns, pest outbreaks, and market volatility are some of the most urgent issues facing agriculture that these technologies may help with (Mishra & Mishra, 2023; Ben Ayed & Hanana, 2021). In agricultural advice services, where timely and correct information can greatly increase farm productivity and income, AI-driven advances have a particularly important influence.

In India, where more than half of the population makes their living from agriculture, effective and easily available extension services are essential (Das, 2024). In remote locations, traditional extension methods frequently fail to reach marginal farmers, resulting in information gaps and less-than-ideal decisions (Juwono et al., 2023; Kumar et al., 2022a). By providing farmers with scalable, real-time, and customized advice services, digital technologies present a workable way to close these gaps. The capacity of chatbots to mimic human conversations and deliver information in local languages has drawn interest. Chatbot platforms are significantly improving information access in underserved regions. In farmer-led assessments involving 1,200 participants, 74% reported that the service was easily accessible, while 68% found the content highly relevant to their agricultural needs. Additionally, 52% of users noted tangible improvements in input utilization and crop planning decisions, highlighting the positive impact of chatbot-enabled support on farming practices (Davi et al., 2014).

With the introduction of Ama Krushi, India's first agri chatbot, Odisha, a state with a robust agricultural foundation and growing technological preparedness, has led the way in the application of AI in agricultural advice. The national objectives of tripling farmers' income and encouraging sustainable agricultural methods are in line with this program, which is part of a larger trend toward digital agriculture. Ama Krushi offers farmers voice-enabled, context-specific assistance with a variety of questions, from crop management to government program access.

The development and effects of Ama Krushi are examined in this review in relation to the broader context of digital agriculture and smart farming (Nautiyal et val., 2024). Based on policy reports, farmer comments, and empirical investigations, the study explores how AI-enabled advice platforms are changing the function of extension services. It draws attention to the successes, drawbacks, and policy ramifications of widespread adoption of these technologies, particularly in socioeconomically and infrastructurally diverse areas like Odisha.

2. TECHNOLOGICAL LANDSCAPE OF AI IN AGRICULTURE

Unprecedented precision, scalability, and responsiveness have been made possible using artificial intelligence (AI) in agriculture. Throughout the agricultural value chain, artificial intelligence (AI) technologies like computer vision, natural language processing (NLP), deep learning (DL), and machine learning (ML) facilitate automation and data-driven decision-making (Ganeshkumar et al., 2023). Weather forecasting, soil analysis, disease and pest

detection, yield prediction, and supply chain optimization are among the tasks supported by these systems.

AI-driven smart farming reportedly builds intelligent decision-support systems by integrating ChatGPT, IoT devices, and satellite data. By enabling real-time monitoring and predictive analytics, these technologies assist farmers in optimizing their pest management, fertilizer, and irrigation practices (Sai et al., 2025). To reduce crop losses and enable early intervention, DL models that use image recognition algorithms, for example, can identify plant illnesses from photos taken by cell phones or drones. By converting intricate scientific information into useful guidance, NLP-based interfaces further improve accessibility, particularly when included into conversational systems such as Ama Krushi (Rane et al., 2024).

Furthermore, by enabling dynamic responses to environmental inputs—like starting irrigation based on real-time soil moisture data—AI and IoT devices work together to promote resource efficiency. Food safety and market trust can be increased by using blockchain technology in conjunction with AI systems to provide traceability and transparency in food supply chains (Kumar et al., 2022b). Together, these developments signify a change in farming practices from reactive to proactive, promoting sustainability and productivity. However, egalitarian access, localized design, and supportive policy contexts are just as important to the success of AI in agriculture as technological robustness.

3. KEY FEATURES OF AMA KRUSHI CHATBOT

Ama Krushi was created to meet the unique requirements of Odisha farmers, particularly considering the state's growing digitization of administration and restricted access to traditional extension services. Being an AI-powered chatbot that speaks multiple languages, it provides users from a range of socioeconomic backgrounds with an engaging and simple experience (Ram et al., 2025). The software offers real-time advising services and relates to agricultural databases maintained by the state government. Among the salient characteristics are:

- **Multilingual Interface:** To improve accessibility across various linguistic communities, Ama Krushi supports Odia,

English, and other regional languages. This ensures effective communication and knowledge dissemination to farmers irrespective of their language proficiency.
- **Voice and Text Interaction:** By supporting both voice and text-based queries, the chatbot overcomes literacy barriers, allowing farmers to access services even if they are not literate. This is especially beneficial for older and less formally educated users (Jimenez-Moreno et al., 2025).
- **Real-Time Query Resolution:** Using natural language processing (NLP), the chatbot comprehends user inquiries and provides prompt, pertinent, and up-to-date information on crop health, pest management, fertilizer application, and irrigation scheduling.
- **Dynamic Advisory Services:** Farmers get information that is specific to their area, crop, and season. In order to provide predictive insights, the chatbot makes use of AI algorithms that access previous trends and satellite data.
- **Government Schemes and Loans:** Ama Krushi offers comprehensive advice on more than 40 programs pertaining to loans, farm mechanization, crop insurance, and subsidies. It acts as a single point of contact for negotiating these schemes' intricate bureaucracy (Benzinho et al., 2024).
- **Integration with State Databases:** Odisha's digital governance system incorporates the chatbot, guaranteeing that the information it provides is precise, relevant to the region, and compliant with legislation (Mishra & Dwivedi, 2024).
- **User-Centric Design:** To ensure usability in remote and infrastructure-poor places, the system is made to be mobile-friendly, functional on low-bandwidth connections, and simple to use.

By combining these features, Ama Krushi enhances decision-making capabilities among farmers, increases access to institutional support, and empowers the rural population to adapt to evolving agricultural practices (Biswal et al., 2025).

4. FARMER-LED EXPERIENCES: ACCESS, USABILITY, AND IMPACT

The evaluation of the actual impact of digital technologies such as Ama Krushi relies heavily on farmer-led experiences. Farmers from all

throughout Odisha have continuously recognized the benefits that the chatbot offers to their farming methods in a variety of field encounters, field studies, comments from Krishi Melas, and training programs. Because of its 24/7 accessibility, farmers can receive advice on important decisions even during emergencies or off-peak times (Tripathi *et al.*, 2022).

The chatbot's local language interface is one of the most notable aspects that users value. Voice commands in Odia make it easier for many elderly and semiliterate farmers to interact with the tool. In traditional extension services, where outreach is frequently constrained by manpower and geographic limitations, this has especially helped close the gap. Farmers have also highlighted how Ama Krushi has developed into a dependable source of real-time information during the cropping season, assisting them in better managing irrigation requirements, pest infestations, fertilizer schedules, and sowing times (Misra *et al.*, 2021).

Additionally, by providing accurate recommendations based on soil and meteorological data, the chatbot has assisted in lowering input costs, according to anecdotal evidence and first field reports. Following the platform's recommendations, several farmers reported avoiding needless pesticide treatments, which enhanced soil health and increased profits.

Ama Krushi has been particularly empowering for women farmers. Many people are interacting with an agricultural guidance system for the first time on their own. It eliminates the constraints of time, distance, and social standing that have hitherto restricted their access to professional guidance. They are now more involved in farm planning and execution thanks to the privacy and convenience of a mobile-based solution.

The experience varies around the state, though. There is still a digital gap. Issues including limited smartphone adoption, inadequate internet connection, and a lack of confidence in utilizing mobile-based services are still problems for farmers in isolated tribal communities. Some users complained that the chatbot was unable to respond to intricate, location-specific queries or was providing advice that was too general. These drawbacks highlight the necessity of ongoing training, localized material upgrades, and last-mile assistance integration with extension agents on the ground.

Improved knowledge of government benefits, easier loan and subsidy application procedures,

and increased readiness for climate disasters like droughts and unexpected rainfall were also mentioned by farmers. The community's interest in more digital agriculture tools has increased because of Ama Krushi's early success, promoting a slow but discernible cultural change toward tech-driven farming. For example, users reported receiving timely and precise information on insect management and fertilizer dosages throughout the rice cultivation season, which helped them prevent crop loss. Their dependence on intermediaries or postponed consultations was also lessened by the real-time responses, which enabled them to react to on-field difficulties more quickly. Women farmers valued the chatbot's privacy and independence since it allowed them to ask for advice on farming without fear of criticism or reliance from others.

Nonetheless, challenges persist. While many younger farmers with smartphones and digital literacy found the tool extremely useful, others struggled with poor internet access, limited mobile data, or lacked the confidence to use digital tools independently. A recurring theme in the feedback was the need for community-level digital training and localized demonstrations to foster wider adoption. Despite these constraints, the initial impact has been promising. Farmers reported increased awareness of government schemes and were able to apply for subsidies or crop loans more easily. The platform also helped in better risk management, especially during climate anomalies, by issuing advisories based on real-time weather data.

- Digital literacy varies significantly across user groups.
- Internet connectivity is inconsistent in remote regions.
- Some users exhibit scepticism towards AI-generated content.
  Nonetheless, many farmers report improved access to schemes, enhanced crop decision-making, and better risk preparedness.

5. INSTITUTIONAL AND POLICY BACKING

Ama Krushi's implementation and success are firmly rooted in Odisha's proactive approach to policymaking and institutional framework designed to change agriculture. As part of a larger effort to improve farm mechanization and digital advising systems, the Department of Agriculture and Farmers' Empowerment, in

partnership with FICCI, started this initiative in recognition of the need for intelligent and easily available extension services.

With its direct connectivity with government databases, field research institutes, and financial inclusion platforms, Ama Krushi is a part of Odisha's digital agriculture strategy. Through AI interfaces, it operationalizes various facets of state-level agri-policy by supporting the implementation of more than 40 government programs, from loans to insurance and subsidies.

At the national level, the action supports the Indian government's objective of doubling farmer earnings, which is outlined in a number of policy plans, including the Digital Agriculture Mission and the National e-Governance Plan in Agriculture (NeGP-A) (Rani, 2022).

A three-pronged policy approach is required to support digital technologies, cross-sectoral the development of environments facilitated by DSI (Digital Sequence Information), and investment in transdisciplinary R&D. These ideas are reflected in Odisha's strategy for implementing Ama Krushi, which connects technology companies, legislators, research institutions, and farmer collectives.

Additionally, frequent capacity-building projects, farmer awareness campaigns, and community-based feedback systems are other ways that policy support shows up. These components guarantee that digital innovations develop in a participative and context-sensitive manner in addition to being top-down deployments. This type of governance model allows for iterative service improvement based on community requirements and increases trust in technology.

6. DIGITAL EXTENSION AND INCLUSIVITY

One of the most important changes in modern farming is the digitalization of agricultural extension services. In the past, these services mainly relied on human middlemen, or extension officers, whose reach was restricted by distance and a shortage of personnel. Disseminating agricultural knowledge has become quicker, more focused, and much more inclusive with the rise of digital tools including chatbots, web-based platforms, smartphone apps, and sensor-enabled technology.

One excellent illustration of how AI-powered platforms may democratize agricultural advising

services is Ama Krushi. Even farmers who are semi-literate or illiterate can obtain timely and pertinent information because to the platform's support for text and voice-based communication in Odia and English. For women and older farmers, who frequently encounter sociocultural obstacles when trying to obtain in-person extension services, this element has proved very powerful. The usability of extension tools is significantly improved by mobile platforms that offer local language support and material tailored to a particular region. By integrating with state policy databases, local agronomic data, and real-time weather updates, Ama Krushi guarantees that its recommendations are not only general but also extremely context-aware. End users are more likely to embrace and trust this as a result (Singh et al., 2023).

Furthermore, the chatbot has an edge over conventional advisory systems due to its ability to operate 24 X 7. Responses can be sent to farmers whenever they want, including on holidays and evenings when conventional extension services aren't available. Its implementation in outlying blocks and tribal regions, where traditional extension efforts are sometimes absent, further increases its inclusivity.

Additionally, the effort is in line with the more general objectives of digital equity. Ama Krushi is helping to create a more equal playing field in rural India by reducing the barrier to entry for technology use and increasing access to real-time guidance. To truly achieve this promise, however, ongoing investments in equitable content production, infrastructure development, and digital literacy will be essential.

- Providing underprivileged farmers with immediate assistance.
- Using voice and vernacular interfaces to improve inclusion.
- Filling in the gaps in language and accessibility to support women and underrepresented groups.

These technologies help to more fairly distribute knowledge and close the information gap between rural and urban areas.

7. CHALLENGES AND LIMITATIONS

Although Ama Krushi presents encouraging answers to persistent shortages in agricultural advice services, several issues still limit its full potential and influence. These restrictions cover

systemic, technical, social, and infrastructure areas.

Technical Difficulties: The chatbot's ability to operate is largely dependent on how well its AI algorithms and data processing skills hold up. Some users have complained about problems like poor contextual awareness, responses that are too generic or erroneous, and a lack of nuanced guidance for complex or unusual requests. As Saikanth et al. (2023) point out, one of the biggest challenges in agricultural extension is maintaining the quality, dependability, and contextual accuracy of digital instruments.

Data Privacy and Cybersecurity: Since the chatbot is linked with government databases and user input, there are concerns over data privacy, informed consent, and secure storage of personal and agricultural data. Clear frameworks for data governance are needed to mitigate these risks.

Social and Cultural Barriers: Many farmers—particularly older individuals—express hesitation in trusting or relying on AI-based solutions. The absence of human interaction, especially in communities accustomed to face-to-face advisory services, can hinder full adoption. Mistrust can also stem from unfamiliarity with digital interfaces or fears of job displacement for traditional extension workers.

Infrastructure Limitations: Poor internet connectivity, limited access to smartphones, and inconsistent electricity supply in rural and remote areas of Odisha impede the seamless functioning of Ama Krushi. Strengthening digital infrastructure in agriculture must be a policy priority to unlock the full potential of such innovations.

Language and Localization Issues: While Ama Krushi supports regional languages, variations in dialects, cultural expressions, and agronomic terminology may still cause misinterpretation. Expanding linguistic datasets and improving NLP models to adapt to hyperlocal variations is necessary.

Inclusivity Gaps: Despite progress, digital literacy remains uneven. Marginalized groups, including tribal communities and women without personal devices, may struggle to access or confidently use the platform. Structured training and digital inclusion efforts are essential.

Maintenance and Scaling: Continuous updates, content validation, and scaling to cover new crops, regions, and languages require sustained financial and institutional support. Without regular upgrades and human-in-the-loop feedback systems, chatbot efficacy may decline over time.

Overcoming these challenges demands a holistic strategy involving multi-stakeholder partnerships, user co-creation, continuous evaluation, and robust policy backing to ensure that AI-driven advisory tools like Ama Krushi remain responsive, inclusive, and resilient.

- **Technical:** Data privacy, cybersecurity, and AI model reliability.
- **Social:** Mistrust among older farmers; resistance to replacing human advisors.
- **Infrastructural:** Limited smartphone penetration and poor rural network coverage.

Addressing these requires public-private collaboration, farmer training, and robust grievance redressal mechanisms.

8. OPPORTUNITIES FOR SCALING AND INNOVATION

Significant opportunities for future innovation and expansion in digital agricultural advice services are made possible by Ama Krushi's success. Several strategic avenues can be taken into consideration to improve its reach, efficacy, and integration with other elements of the agri-tech ecosystem, building on its early successes and taking stakeholder comments into consideration (Prajapati et al., 2025, Khatri et al., 2024).

Geographic and Crop Diversification: Adding more crops to the platform's coverage beyond staples like paddy is one of the most pressing opportunities. A wider range of applications will be possible by including cash crops, pulses, and horticulture. Furthermore, regional digital agriculture initiatives can be sparked by Ama Krushi's replication in other Indian states with comparable agro-ecological circumstances.

Integration with IoT and Remote Sensing: Real-time field-level monitoring is possible by fusing Ama Krushi with satellite data and IoT-based sensors. This would enable the chatbot to offer hyper-localized advice on insect monitoring, soil health, and watering. These kinds of linkages, especially in precision farming applications, can save input costs and increase sustainability.

Predictive analytics and early warning systems: Farmers can be better prepared by

using AI models to predict disease incidence, insect outbreaks, and extreme weather events. Chatbot-triggered alert systems have the potential to save lives, particularly in areas that are vulnerable to natural disasters. Given climate change and unpredictable monsoons, these forecasting skills are essential.

Links to Online Marketplaces: A smooth production-to-market pipeline can be established by integrating Ama Krushi with agri-e-commerce platforms. In addition to crop management, farmers might get advice on procurement centers, logistics planning, and market price trends. This would raise farm gate pricing and lessen reliance on intermediaries.

Multilingual NLP and Voice Expansion: Chatbot accuracy and accessibility will be enhanced by more advancements in natural language processing (NLP) models, such as support for regional accents and dialects. Farmers who are less tech-savvy will also accept it more if its voice command features are expanded.

Cooperation with Private Agri-Tech Companies: Public-private partnerships (PPPs) can provide more resources, knowledge, and creativity to improve and expand the platform. Co-developing APIs, crowdsourcing agricultural expertise, and offering cloud infrastructure for increased scalability are some examples of this.

Personalization and AI Learning Loops: Over time, more sophisticated chatbots can be trained to comprehend the unique characteristics of individual farmers by accounting for past inquiries, regional trends, and user preferences. This would enable smarter, more individualized advice services that change as the user does.

Including Feedback Mechanisms: By creating two-way lines of communication where farmers can rate answers or report errors, the AI model and its content can be continuously improved to ensure relevance and trust.

By taking advantage of these chances, Ama Krushi has the potential to develop into a full-fledged agri-advisory ecosystem that will give farmers the tools they need to make decisions, build resilience, and connect with markets—all of which are critical for India's sustainable agricultural future.

- Integration with IoT for real-time soil and weather data,

- AI-driven alerts for pest outbreaks and climate risks,
- Interfaces with e-markets to support price discovery and direct sales.

Scalable models can be replicated across states with similar agro-climatic conditions, promoting national digital agriculture goals.

9. CONCLUSION

Ama Krushi represents a significant advancement in the digital transformation of agricultural extension services in India. By leveraging artificial intelligence and a farmer-centric design, this chatbot bridges geographic and socioeconomic divides, providing thousands of previously underserved farmers with timely, localized, and accessible agricultural information. Its multilingual, voice-activated interface effectively lowers barriers for diverse user groups, including women, the elderly, and less-educated farmers, thereby promoting inclusive rural development. Beyond simply delivering advice, Ama Krushi empowers farmers to make informed, data-driven decisions—ranging from navigating government schemes and crop insurance to pest detection and optimizing fertilizer use. This shift fosters greater technological confidence and independence among rural users, marking a movement toward modernization and knowledge-based farming. The success of Ama Krushi underscores the critical role of supportive institutional ecosystems and collaborative public-private partnerships. With the backing of the Odisha government, industry stakeholders, and technology providers, the chatbot serves as a model for effective alignment between digital innovation and existing agricultural governance frameworks.

Nonetheless, challenges such as technical limitations, the need for hyper-localized content, and the balance between automation and human advisory inputs remain. Continued investment in rural digital infrastructure, AI training with contextual data, and ongoing farmer feedback will be essential for scaling and refining the platform. Addressing concerns around digital literacy, data privacy, and responsible AI use is also vital to ensure equitable and trustworthy service delivery.

Looking ahead, Ama Krushi has the potential to evolve into a comprehensive agricultural ecosystem encompassing sensor integration, marketplace linkages, climate resilience

frameworks, and personalized advisory engines. Such innovation can play a pivotal role in India's goals of doubling farmer incomes, enhancing food security, and fostering climate-resilient agriculture. In essence, Ama Krushi transcends its role as a chatbot—it embodies the convergence of AI and traditional agricultural knowledge to drive inclusive, sustainable, and digitally empowered rural development. As a pioneering model, it offers valuable lessons for scaling AI-driven agricultural extension services both within India and beyond.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declares that no generative AI technologies such as large language Models and text to image generators have been used during writing and editing the manuscript.

COMPETING INTERESTS

Authors have declared that they have no known competing financial interests or non-financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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