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## **Short Research Article**

# **Chatbot for promoting best crop management practices to rice farmers in Odisha, India**

### **ABSTRACT**

The increasing penetration of mobile phones has made it easier to reach remote farmers and bridge the knowledge gap between them and researchers/extension workers and agricultural stakeholders. Farmers need concise, context-specific, information to address the challenges which arise due to lack of near-real time updates. Scaling up innovative agricultural technologies is essential to ensure these advancements reach the farmers for their benefit. Chatbots represent an informative tool for delivering the latest agricultural developments to farmers in a user-friendly and interactive format. Chatbots can deliver information on best agronomic practices, weather forecast, market information thereby improving the decision-making capacity of farmers. This paper discusses the development of a rule-based chatbot under a pilot-study and presents findings from a user study conducted with 102 farmers in Odisha, India in 2021. The content topics were decided using a participatory approach wherein farmers selected the topic of interest and required information. The content was developed using the digital tools Rice Crop Manager (RCM), Seed Cast and Rice Knowledge Bank (RKB) developed and deployed by International Rice Research Institute (IRRI). The chatbot is hosted on Facebook messenger platform and needs the internet support to operate. Farmers having this app can use the chatbot without any additional expense. The results indicate that farmers acknowledged and appreciated interactive features of chatbot and content but expressed a desire for more comprehensive information on insect-pest management and other crop management practices. The findings highlight the potential of chatbot as a complementary channel to disseminate agro advisories, complementing the existing agricultural extension services. The study has its limitations in terms of small sample size which may or may not represent the variability of the entire population of the area.

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*Keywords: chatbot, precision agriculture, rice cultivation, best management practices, agricultural extension, fertilizer, easy access to information, digital tool*

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## 1. INTRODUCTION

22 In developing countries like India, agriculture is the backbone for generating livelihoods for  
23 the rural population. With 66% of the population living in rural areas and 42% are dependent  
24 on agriculture for their livelihood (Gulati A and Juneja R 2021), the agricultural sector  
25 shoulders the responsibility of feeding the country's 1.4 billion people. To maintain food  
26 security, efficient production measures are required within the agricultural system. Despite  
27 ongoing research to improve crop production and productivity, it takes years and sometimes  
28 decades for the new innovative technologies to reach the farmers. Transfer of new  
29 innovations from scientists and labs to farmers' fields mainly happens through the extension  
30 services, both private and public (Yadav K, 2023). However, the agriculture extension  
31 system in India faces significant challenges, including manpower crunch as out of 143,863  
32 positions in the Department of Agriculture, only 91,288 posts are filled (Gulati et al. 2018).  
33 Agriculture extension system needs supplementary support from other innovative  
34 approaches to accelerate the delivery and dissemination of new technologies being  
35 developed for the farmers (Gopalakrishnan B, Sylvia E, 2023).

36 Information and Communication Technology (ICT) has emerged as a crucial intervention,  
37 providing quick and timely access to innovative technologies and knowledge products  
38 through various digital tools (Hamad, Wahid 2018). With the increasing penetration of mobile  
39 phones and internet in villages, agriculture advisories can be disseminated quickly with  
40 limited involvement of extension staff (Panda, Subhrayoti & Das 2019). Farmers receive  
41 advisories through various digital communication platforms such as SMS, WhatsApp,  
42 Facebook messenger, and Kaizala (Devesh, 2018). However, most of these platforms use  
43 one-way communication to transfer advisories from experts to the farmers which lacks the  
44 human centric approach. This paper examines the development and deployment of a  
45 chatbot - a two-way communication platform designed to transfer agricultural advisories to  
46 the farmers of Odisha. The goal here is to reach farmers directly in their fields and homes,  
47 providing timely advice at their beck and call.

48 In Odisha , the rice production has increased from 46.14 Lakh MT during 2000-2001 to  
49 115.00 Lakh MT during 2022-23 which is about 2.5 times over the base year, however the  
50 productivity remains low at 2.9 t/ha (Krushi Odisha 2024). Most farmers practice rice  
51 production using traditional methods as the information on new technologies are limited  
52 (Nayak A K et al 2020) . Extension staff play an important role to co-create awareness on  
53 new technologies and encourage farmers to adopt those, in turn increasing the production  
54 and productivity of the cropping system(Kumar N et al, 2023).However, the extension  
55 system in Odisha has its limitations in terms of resources. For instance, Odisha spends only  
56 0.03 per cent of the GDPA on the extension system whereas the national average is 0.16  
57 per cent. Further agriculture extension intensity in the state is one of the lowest in the  
58 country standing at Rs 19.1 per hectare as compared to the national average of Rs 95.2 per  
59 hectare (V T Onima 2018). An advisory tool like chatbot can help the extension staff in quick  
60 and timely dissemination of information about the advances in science and technology. As  
61 per the TRAI report, the number of internet users are rising in Odisha. In the eastern region  
62 of India comprising of West Bengal, Bihar and Odisha, in rural regions, the number of  
63 subscribers of the internet users in hundred population is maximum in Orissa (29.54),  
64 followed by West Bengal (23.38) and Bihar (20.60), which indicates the potential to reach out  
65 to farmers through ICT(Moinuddin S, 2021). However in 2021, when the study was done, no  
66 significant number of conversational bots were available for the farmers of Odisha.

67 While timely access is crucial, it is equally important to select the content to meet farmers'  
68 specific needs. Often, farmers are overwhelmed with irrelevant information, which can lead

69 to scepticism about these services (Nikam V, Ashok A, Pal S, 2022). To address this gap, an  
70 interactive communication tool/chatbot was developed, specifically for the farmers in Odisha.  
71 The word chatbot is composed of two parts: “chat,” that means to converse, and “bot,” that  
72 comes from a robot. Chatbot is a program capable of “conversing” with users, responding to  
73 specific questions, and automatically providing suggestions based on users’ needs and  
74 queries (Adamopoulou E, Moussiades L, 2020). A tool that is convenient and practical,  
75 accessible to farmers and agricultural extension workers anytime of the day, delivering  
76 information on best management practices tailored to their needs(Biswas,Som,2023). The  
77 chatbot interface is menu-driven, with input options leading to synthesized text string and  
78 audio file. The same chat interface is used to deliver the content to the farmer. In agriculture  
79 Chatbots are being used to provide information on crop management , analyzing market  
80 trends, detecting crop diseases and pests, and optimizing resource usage (Zaiba Khan,  
81 2023). Chatbots are emerging as virtual agricultural advisors to disseminate best agricultural  
82 practices (Tripathi S 2024).

83 Different types of chatbots vary in features based on their application. Popular types include  
84 menu-based, rule-based, AI-based, voice chatbots, and generative AI chatbots (Church B,  
85 2023). Some of the popular chatbots available today for farmers are Plantix for plant  
86 diseases (Samal et al. 2023); AgroBuddy for weather updates (Haseemun and Somasekhar,  
87 2023); KisanSuvudha (Bisheko, Muganyizi & G, Rejikumar. (2023) for market information etc.  
88 This paper focuses on the development and evaluation of a rule-based chatbot, which uses  
89 if/then logic to develop conversation flow. With predefined question-and-answer  
90 combinations based on user input, this tool simulates a real-time conversation, making the  
91 interaction engaging and keeping the user interested. Users also have the option to pause  
92 the conversation and resume it later, based on the needs. The novelty in this Chatbot is the  
93 use of RCM for providing site-specific advisories on nutrient management as well as  
94 information on the seed suitability and availability with detailed information on seed dealers.

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## 97 **2. MATERIAL AND METHODS**

### 98 **Selection of platform for hosting chatbot**

99 The first step in developing a chatbot was selecting a platform to host it. The chatbot  
100 can be developed as an independent application or integrated into existing  
101 messaging platforms. A survey was conducted in four villages to determine the  
102 digital communication platforms most commonly used by farmers. WhatsApp  
103 and Facebook Messenger were the top two platforms for digital communication.  
104 Facebook Messenger was found to be the most suitable for hosting a chatbot  
105 due to its cost-effectiveness, support for the Odia language, and ability to handle  
106 audio files. Consequently, this platform was selected to host chatbot. The study  
107 is focused on the following research objectives:

- 108 1) Using user-centered design, identify the priority content of best crop  
109 management practices for farmers and agricultural extension workers in Odisha,  
110 India
- 111 2) Design, develop and deploy a chatbot intended to increase the adoption of best  
112 crop management practices for farmers in rice-based agri-food systems in  
113 Odisha.

114 3) Conduct a user-test to collect the feedback of farmers for further improvement of  
115 chatbot and similar technologies.

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### 117 **Selection of Topics for Content**

118 A survey was conducted using a structured questionnaire to identify the rice crop management  
119 information farmers were most interested in. The survey was conducted in two districts: Puri  
120 and Balasore, covering four villages with 32 farmers ranking crop management topics. The top  
121 four topics selected were seed availability, suitable seed varieties, crop loans, and fertilizer  
122 management. Based on these priorities, the content for the chatbot was selected from three  
123 main sources:

- 124 1. IRRI's Rice Knowledge Bank (RKB): A web-based digital extension service providing  
125 information on rice production techniques and crop management practices based on  
126 IRRI's research findings and other national research findings  
127 ([www.knowledgebank.irri.org](http://www.knowledgebank.irri.org)) .
- 128 2. SeedCast: A mobile app developed by IRRI that collates demand for rice seeds from  
129 dealers and to provides information on suitable rice varieties for specific locations  
130 ([www.irri.org/seedcast](http://www.irri.org/seedcast)) ; and
- 131 3. Rice Crop Manager for Odisha: A web-based tool offering site specific advisories on  
132 nutrient management for rice fields ([www.irri.org/crop-manager](http://www.irri.org/crop-manager) ).

### 133 **Content Details**

- 134 . Seed Suitability: Provides information on stress-tolerant varieties (STRVs) suitable for  
135 specific areas based on local stress conditions. The chatbot suggests a list of suitable  
136 STRVs that can be grown in the area based on the farmer's queries;
- 137 a. Seed Availability: Lists seed dealers in the area along with their contact details, allowing  
138 farmers to enquire about the availability of the desired varieties;
- 139 b. Nutrient Management: Offers site-specific advisories for nutrient management in rice  
140 fields, with details on the rate and timing of fertilizer application. These advisories can  
141 also be accessed in regional language, Odia, through audio clips; and
- 142 c. Links to Additional Resources: Links to the Rice Knowledge Bank  
143 ([www.knowledgebank.irri.org](http://www.knowledgebank.irri.org)) and Rice Doctor ([www.irri.org/rice-doctor](http://www.irri.org/rice-doctor)) were included  
144 in the menu for farmers seeking more detailed information on crop management and  
145 pest and control of insect-pest and diseases.

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### 147 **Technical Architecture of Chatbot**

148 The chatbot was developed using Facebook Messenger to provide step-by-step instructions  
149 for input parameters and generate appropriate responses to farmers (Figure 1). The chatbot  
150 supports both English and Odia languages, and all conversations, including audio files, are  
151 stored in a database at the server. The output is synthesized as a text string based on input  
152 parameters. An interactive dashboard was developed to present data and usage analytics.  
153 The paid version of Chatfuel (Facebook Messenger) was used to enable the chatbot service,  
154 with MySQL for database storage. Non-clustered indexes were applied where appropriate,  
155 and the application was developed using PHP and JavaScript.



183 the participants reported using the information for themselves, 4% for others (including  
184 family members and neighbors), and 26% did not specify who would use the information.

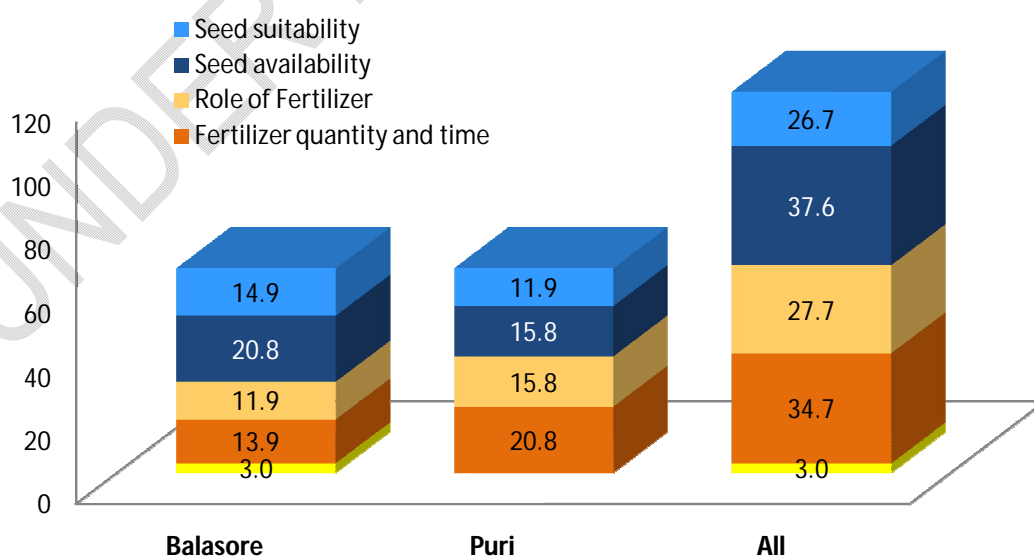
### 185 **Farm characteristics of farmers**

186 The average area of land used for rice production was 1.19 hectares and 0.63 hectares in  
187 Balasore and Puri, respectively. In Balasore, rice farm sizes ranged from 0.40 to 3.60  
188 hectares, while in Puri, they ranged from 0.40 to 1.60 hectares. Majority (68%) of farmers  
189 preferred short-duration rice varieties. Although 20% of respondents did not specify their  
190 preferred variety, a small number reported using long and medium-duration varieties, and  
191 4% used stress-tolerant varieties. Few farmers (8%) identified submergence as major stress  
192 affecting their rice fields. The reported yields were similar between the two districts, with  
193 4,554 kg/ha in Balasore and 4,751 kg/ha in Puri during the 2019 Kharif season. Although  
194 33% of farmers did not plant during 2019-2020 Rabi seasons, the average yield during Rabi  
195 was higher, with an average of 4,916 kg/ha in Balasore and 5,225 kg/ha in Puri. Most  
196 farmers in Odisha practiced manual harvesting.

### 197 **Requested crop management information**

198 Twenty one percent of farmers in Balasore and Puri were mainly interested in seed  
199 availability and the amount of fertilizer and its timing of application in rice farming,  
200 respectively (Figure 2). Apart from fertilizer advice, farmers in Balasore did not emphasize  
201 enough on the role of fertilizer (12%), while seed suitability was the least concern for farmers  
202 in Puri (12%). Overall, farmers in Odisha showed great interest in knowing about seed  
203 availability in their respective districts.

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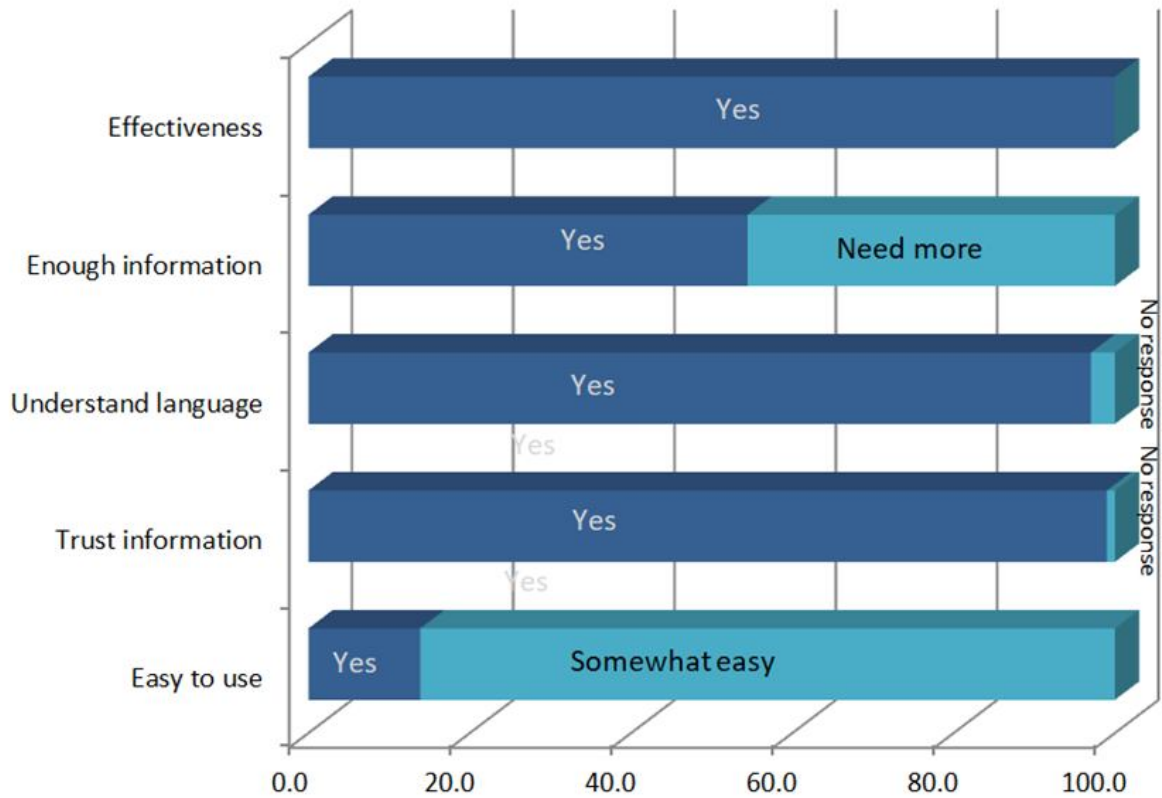


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Figure 2. Distribution of topics selected by farmers for near-real time advisories.

207 **Participant's satisfaction**

208 The feedback from farmers who used the Chatbot was overwhelmingly positive, reflecting a  
209 strong potential for this technology in agricultural extension services. Majority (88%) of  
210 farmer-participants reported being very satisfied with the Chatbot's ability to provide them  
211 with useful information that would help in their rice farming activities. While 55% felt they  
212 received enough information, 45% believed that the information provided was limited to three  
213 topics and suggested adding more. These farmers expressed a desire for the inclusion of  
214 more diverse topics, particularly those related to insect-pest management, weed control,  
215 weather forecasts, agricultural machinery, and updated pesticide and herbicide  
216 recommendations. This feedback underscores the opportunity to expand the chatbot's  
217 content to better meet the comprehensive needs of farmers. In terms of usability, the chatbot  
218 was well-received, with 14% of participants finding it easy to use and 86% rating it as  
219 "somewhat easy." Farmers appreciated the interactive nature of the chatbot, which allowed  
220 them to ask specific questions and receive tailored responses (Figure 3). The conversational  
221 style was particularly effective in maintaining engagement, as it made the interaction feel  
222 more personal and less mechanical.  
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Figure 3. Acceptability of the chatbot regarding the information provided, language used, effectiveness and if user-friendly

228 The combination of text and audio delivery was highly favored, with 98% of participants  
229 preferring this dual approach. The audio clips, which were available in the regional language  
230 Odia, were particularly well-received, with 97% of users reporting that they liked this feature.  
231 The audio format was seen as an important tool for enhancing understanding, especially for  
232 those who may have literacy challenges or prefer auditory learning.  
233 When evaluating the time it took to receive the information, 83% of farmers felt that the  
234 duration was just right—not too long or too short. This suggests that the chatbot's efficiency  
235 in delivering information meets the needs of the farmers without causing frustration due to  
236 delays or overload.

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238 The clarity of the chatbot's responses was also highly rated, with all participants finding the  
239 answers to be either mostly clear or very clear. This indicates that the chatbot effectively  
240 conveyed the information in a way that was easily understood by the users, which is crucial  
241 for ensuring that the advisories are actionable.

242 Regarding future use, 96% of the farmers expressed their intention to use the chatbot again,  
243 demonstrating strong acceptance and a positive outlook on the technology while the  
244 remaining 4% were unsure, possibly indicating a need for further refinement or additional  
245 features to fully meet their expectations.

246 Farmers also suggested several enhancements that could improve the chatbot's utility.  
247 These included real-time updates on seed availability and prices from local dealers, which  
248 would assist them in making timely purchasing decisions. Additionally, some farmers  
249 accessed the Rice Knowledge Bank (RKB) link provided by the chatbot to seek more  
250 detailed information, which shows the potential for integrating more in-depth resources within  
251 the chatbot's interface.

252 Overall, farmers were excited about using the chatbot, appreciating its conversational mode  
253 and two-way communication. They noted that as smartphone usage increases in villages,  
254 such applications will be increasingly sought after to enhance their knowledge.

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#### 257 **4. CONCLUSION**

258 The pilot study under the seed grant project highlighted the significant potential of using  
259 chatbot as an interactive medium to engage with farmers and deliver tailored agricultural  
260 advisories. Farmers appreciated the ability to access relevant content through the  
261 Messenger app and valued the option to choose specific topics that met their immediate  
262 needs, rather than being overwhelmed by irrelevant information. The positive feedback  
263 indicates that chatbot can enhance the effectiveness of agricultural extension services by  
264 providing timely, user-centered support.

265 Moreover, the study revealed a clear demand among farmers for expanded content,  
266 particularly in areas like insect-pest management, weed control, and other crop management  
267 practices. The findings support the results from study done in Nigeria to evaluate the chatgpt  
268 responses to help the extension staff in delivering information, and found it useful (A Ibrahim  
269 et al, 2024). This suggests a strong opportunity to further develop and refine the chatbot,  
270 making it a more comprehensive tool that can address a broader range of agricultural  
271 challenges. The team is working to advance this chatbot to an AI-enabled chatbot by using  
272 the server data of digital tools developed by IRRRI. The advanced chatbot will be able to  
273 provide weather-based advisories on nutrient management, pest management and weed  
274 management along with the information on seed suitability and availability. As smartphone

275 penetration continues to grow in rural areas, the integration of such technology into the  
276 agricultural advisory system could play a crucial role in improving productivity and  
277 sustainability in farming communities. However, the small sample size is a limitation of the  
278 study. It diminishes the statistical power of the analysis and limits the generalizability of the  
279 findings. A Smaller number of samples may or may not represent the diversity of the  
280 population leading to potential biases in the result. Further research with a wider sample size  
281 will confirm and expand upon these results.

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#### 284 **CONSENT**

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287 All authors declare that 'written informed consent was obtained from the farmers for  
288 publication of this case report and accompanying images. A copy of the written consent is  
289 available for review by the Editorial office/Chief Editor/Editorial Board members of this  
290 journal.

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#### 293 **Disclaimer (Artificial intelligence)**

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296 Author(s) hereby declare that NO generative AI technologies such as Large Language  
297 Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during the  
298 manuscript development.

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UNDER PEER REVIEW